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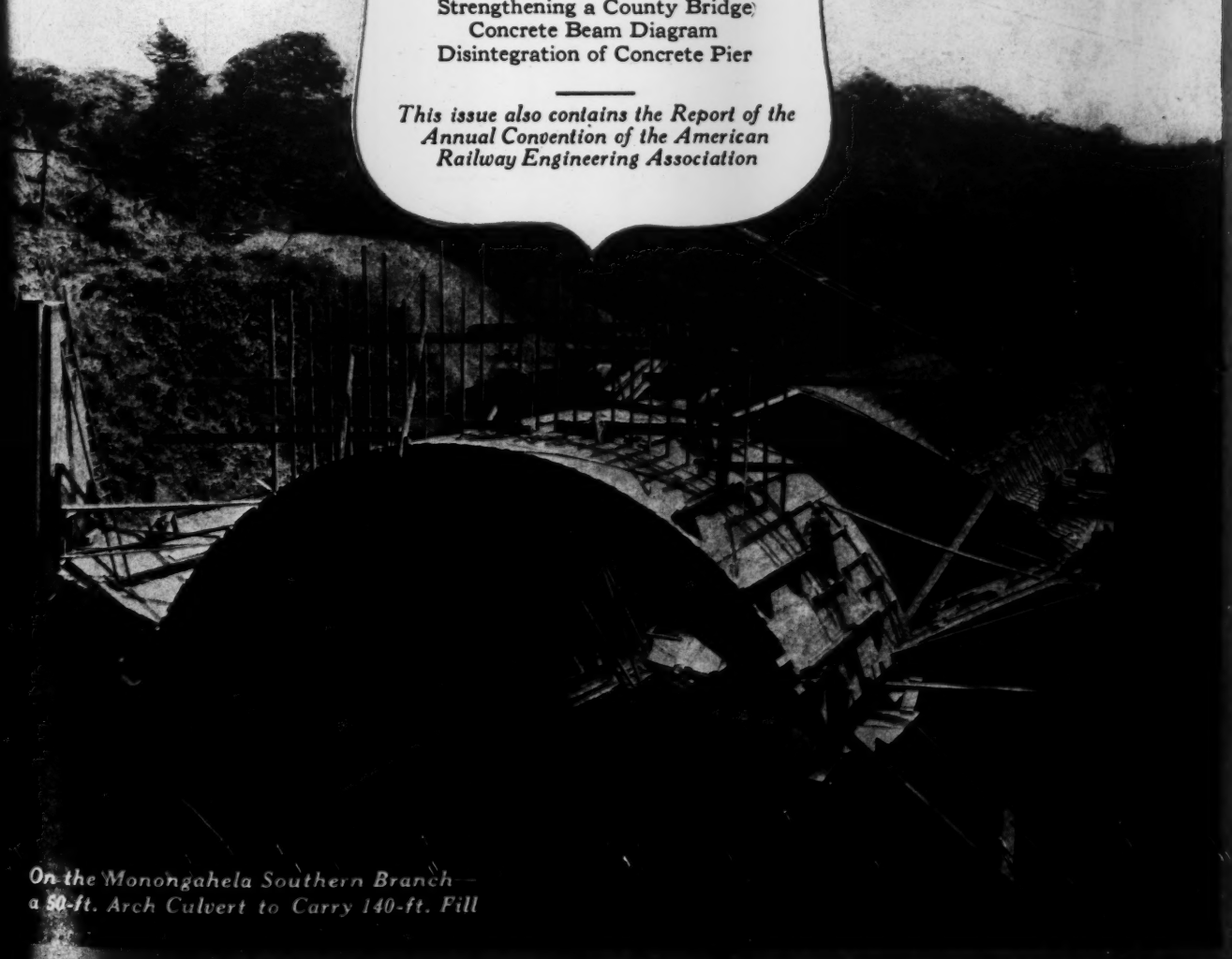
"A piece of railway engineering remarkable alike in its conception and in the line location and construction involved"
—Thus is characterized the work on the Monongahela Southern branch described in leading article this week

OTHER ARTICLES:

Lugs or Lugless Brick?
Strengthening a County Bridge
Concrete Beam Diagram
Disintegration of Concrete Pier

This issue also contains the Report of the Annual Convention of the American Railway Engineering Association



On the Monongahela Southern Branch — a 50-ft. Arch Culvert to Carry 140-ft. Fill

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ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING
AND CONTRACTING

E. J. MEHREN
Editor

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Registration in England

THERE has been noted in these columns the proposed effort of the Institution of Civil Engineers, of Great Britain, to have passed by Parliament a law requiring the registration of engineers. It is the understanding in England that the law will cover all engineering practice, the term "civil engineer" to be used in its broad sense, as including all engineering other than military. Rumor has it, also, that the bill will likely provide that the control of the registration shall be vested in the Institution of Civil Engineers. To this possible method of control vigorous protest has been voiced. The Executive Committee of the Society of Engineers, has set forth that the broad interpretation of the term "civil engineer" is no longer justified and that the institution "though a competent authority as regards its own members, has no mandate from the the engineering profession as a whole to act on its behalf." Protest has also been made by B. Wyand, secretary of the Institution of Municipal Engineers, his protest being much along the lines of that of the society mentioned. It is important, however, to note that neither the Society of Engineers nor Mr. Wyand takes exception to the proposal of registration, but merely to the extent to which the Institution of Civil Engineers shall be the governing or administrative body. In fact, Mr. Wyand says very explicity that civil engineering will sooner or later become a "close" profession. We take it, therefore, that the engineers of Great Britain favor registration—a fact that is of interest in view of the discussion over licensing in this country.

New York's Local Freight Problem

GEORGE H. PRIDE, the well-known New York operator of motor trucks, and president of the Heavy Haulage Co., in a Letter to the Editor in last week's issue criticised severely the engineers of the proposed Hudson River vehicular tunnel for not providing for three traffic lines in each direction. With Mr. Pride's argument on the immediate need for three-way traffic we do not now propose to deal, but want to point out the erroneous assumption on which his whole thought seems to be based—that we should look for the solution of New York's freight-handling problem to vehicular tunnels and motor trucks. When thus presented in its baldness, Mr. Pride, himself, will probably deny that he entertains any such view, yet a careful reading of his letter shows that that thought runs through his letter. The controlling factor in freight distribution in New York City with present methods of distribution is the capacity of the city streets. Already the congestion everywhere south of Fifty-ninth Street is serious; it usually shows itself at intersections. To bring more freight across the river on motor trucks will not, at first thought, seem to add to the congestion, for the same freight must be delivered whether direct from the Jersey Yards or with the aid of lighters. However, there will be added truck mileage due to distribution from a few points—the tunnel portals on Manhattan Island—rather than from many lighterage piers. But even if there were no added traffic now, the increase in the port's business would add it in the future. Indefinite increase of traffic on New York's streets is, of course, out of the question. Therefore, we should not delude ourselves with the error that the vehicular connection with New Jersey will solve New York's local freight-handling problem. Only by approaching this question in a broad way can we hope to solve it. Rail connection with New Jersey for freight, and subsurface distribution, combined with either a subsurface or elevated belt—along these lines must we work to handle New York's freight.

If Question 3 Should Fail?

WHAT will happen if in the questionnaire ballot being taken by the American Society of Civil Engineers the vote should be adverse to Question 3, relating to the organization proposed by the Joint Conference Committee? The members of the society's board of direction were parties to a meeting, informal of course, at which approval was given of steps to organize the comprehensive organization proposed. Notice was given at that time that the society's view would not be known until the questionnaire ballot was canvassed; and the clearly implied reservation undoubtedly applies, as well, to the subsequent action in directing the society's representatives to participate in arranging for the organizing meeting. All of which indicates that it would not be improper for the society, in case of an adverse vote, to refrain from participation in the proposed organization. But, in the words of the song, "Where do we go from here?" Without a doubt, even if the civil engineers' society should refuse to participate, the other societies would proceed with the organization—and should proceed with it. The situation would be similar to that which obtained when the other national societies accepted the Carnegie gift and established a common home—with the civil engineers left out. The other societies successfully worked out a difficult problem and changed the engineering center of the country from Fifty-seventh Street to Thirty-ninth Street, New York. Then, belated, the civil engineers came into the building. So, too, it would probably be with the comprehensive organization. After the other societies had solved the problems, the civil engineers would feel it their duty to come in. We believe they should be in at the start. Their counsel, their ideals are needed, particularly in the preliminary stages. It will be a calamity if the civil engineers should fail to participate. There are those, on the contrary, who believe that it will be a calamity *for the society* if it does participate. These are the men who feel that the

society, directly or indirectly, should have only technical activities. We are heartily in agreement with them in wanting to guard jealously the technical ideals which have made society the leading engineering organization, but we do not believe that participation in a welfare organization will be detrimental. We have such faith in the mass of engineers that we believe that the work of the comprehensive organization will not be unworthy of or detrimental to the profession. Democracies have their dangers, it is true, but we are willing to trust them somewhat more than many of the opponents of the Joint Committee's proposal.

New Factors in Planning Railway Improvements

RADICAL changes in rules governing railway location and relocation and in plans for other improvements are likely to be introduced, owing to the changed operating conditions which will result from the new scales of wages and overtime for employees in freight-train service. Low grades, in particular, will be a much less important factor than formerly in both location and revision, while measures for insuring uninterrupted movement will be of greater importance than those providing for very heavy trains. These views are expressed by the American Railway Engineering Association's committee on economics of railway location and will be noted with interest by all railway engineers.

For years freight-traffic economics have been gained by steadily increasing the weight of trains. These heavy trains, in fact, are characteristic of American railway practice. Great sums have been spent in reducing grades to a profile favorable for the operation of such trains. Speed necessarily is slow and the trains are difficult to handle, so that delay and loss of time occur when movement is interrupted by stops or switching to keep out of the way of faster or opposing trains.

Two methods are available to avoid excessive labor cost under the new wage scales. Either the divisions must be shortened to enable the present heavy and slow trains to make their trips without overtime charges, or traffic must be handled in a greater number of lighter and faster trains. The former alternative would require the moving of terminal facilities, while the latter would involve the construction of additional running tracks. In the opinion of the committee the change in character of trains will be the more economical method by far, although it is a direct reversal of the present system of handling freight traffic.

To attain this economy, however, it will be necessary to avoid intermediate stops, such as for clearing other trains and taking water. For this reason the provision of track tanks and additional running tracks may be of greater economic importance than the revision of line to secure low grades and easy curvature. It will mean, also, the double tracking of many single-track lines and additional tracks for busy double-track lines, since the handling of heavy traffic on such lines involves frequent sidetracking to allow the passage of other trains.

Electrification of railways will have an additional value under the new conditions, according to the report, while an appendix by E. H. McHenry points out that electric traction will seriously affect the economic values heretofore assumed for the items of distance, rise and fall, curvature and rate of grade.

On the whole, it appears evident that in future the engineer locating new lines or planning improvements of old lines will be governed by considerations differing considerably from those of the past.

A Sane Study of Column Strength

MOST engineers, we think, will welcome the news that a straight-line column formula was finally settled upon by the American Railway Engineering Association for use in the design of steel bridges. Both the Gordon and the straight-line types of formula have extensive following, whereas the parabolic formula proposed to the association a year ago has only few scattered adherents. As between a Gordon and a straight-line formula devised for corresponding service there is little to choose; each has its advantages and its defects and each will produce good results. The straight-line formula, however, is distinctly the more popular.

Even more important than the decision in favor of a straight-line formula, however, is the study and discussion of the column subject on which the decision was based. Prof. F. E. Turneaure, who carried out this study, has contributed a report of singular lucidity to the confused mass of literature on column strength that has accumulated during the past few years. For one thing, his analysis of the several series of experiments on record, together with his application of each of them to the question of a working stress formula, is of fundamental value. Further, his incidental reference to the fact that square-end tests and square-end formulas have no immediate application to bridge design, but must be transformed to a round-end basis, is most helpful. There are, in fact, two separate kinds of misunderstanding on this point that have been not uncommon: the first one, that many compression members in bridges are actually square-ended or restrained, whereas the fact is that apparently fixed ends are either free to rotate (as in compression chords) or free to shift laterally (as in portal posts); the second, that square-end and hinged-end column action are substantially identical, a belief opposed to both theory and test results. Professor Turneaure's report disposes of both these misunderstandings.

Dealing with a phase of detail design he again succeeds in destroying a widespread error. There has long been a rule of design that a composite column, built of separate ribs connected by lattice or other bracing, should be so proportioned that the length-ratio of a rib segment is not greater than the length-ratio of the whole column. Much mischief has been done by this rule. It bases on a wholehearted misappreciation of column resistance, and so long as this prevailed no sound thinking on column detailing could develop. A single paragraph of Professor Turneaure's report deals with lattice spacing, but this one paragraph is of a kind to form a lasting contribution to the literature of column design.

There is one point of the report, however, whose relation to broad problems in structural design is so direct as to warrant our marking it as easily the most important. This point is the statement and proof of the fact that when a straight-line formula is shifted to a

higher or lower register, so to say, the same factor must not be applied to both terms. When a high-strength steel is used, for example, and the base stress of the column formula is to be raised from 15,000 per sq.in. to 30,000, it is not correct to merely double the subtraction term. Unless this term is increased in greater ratio than 2:1, the formula will be falsified in its higher ranges, where it is related to buckling action and the Euler formula. The modulus of elasticity of the steel controls buckling, and this quantity is no greater for high-strength than for ordinary steel.

What lies at the bottom of the question thus raised, however, is not mere mathematics but the highly empirical (and highly important) question of factors of safety. This needs far more study and reflection than it has yet received. Is it proper engineering that the same safety-factor against ultimate failure (i.e., testing-machine failure) be provided in three columns of length-ratios 40, 100 and 175? We think it is not, and we believe that every engineer in a case of practical designing of columns does in effect apply different safety factors. But the question—which has not yet been subjected to discussion—needs to be answered more specifically. Upon the answer will depend not only the manner of transforming a formula when applying it to high-strength steel, but also the whole question as to what is the best column formula for use in designing practice.

In bringing such matters as this to the front, the present report on a study of column strength performs most valuable service. Its healthful influence in developing sound and progressive habits of thinking on steel-column practice is certain to be felt for a long time.

Progress in Bridge Thought

MANY months of hard work and diligent discussion preceded the final formulation of the new bridge specification adopted by the American Railway Engineering Association last week. In the form of preliminary draft, presented at the meeting of a year ago, this specification had certain obvious defects and encountered very strong opposition, with the result that many revisions were made during the past year's work. There are still differences of opinion, but the vote of adoption means that the final document is workable and meets prevailing views on good construction in the field of steel bridges. Inasmuch as it differs from its predecessor, the 1910 specification, in many important requirements, and also is of widely different form, the change is certain to have distinct influence on bridge thought. In fact, it may initiate a new period of development of structural ideas.

There was an attractiveness in the rugged simplicity of the earlier specification that the new one lacks. Detail clauses have been inserted in large numbers. In a sense the two documents represent opposite views of a bridge specification: the older one, that specification requirements are best held down to a minimum in number and stringency; the new one, that elaborate detail clauses and limitation of freedom in designing are desirable. The work of the detailer will probably be simplified by the new document. On the other hand the designer may receive less help from it than from the old one.

In view of the wide currency which the older specification won for itself, we may fairly emphasize the fact that it produced excellent bridges. It was safe; and while it could be used either economically or wastefully, and could even be applied in such a way as to produce unsatisfactory construction, these characteristics do not necessarily form grounds for proper criticism. It remains to be learned whether a specification can be made so comprehensive and detailed as to assure good design and sound detailing in every point. Or, if it is found that this can be done, whether the specification would not then prove too restrictive for most flexible and efficient service.

When the first draft of the new specification was presented, a year ago, some surprise was occasioned by the committee's limiting its application to spans not exceeding 300 ft. in length. This limitation has been retained in the revision. Its justification is that in the case of a long span special considerations are apt to assume dominant importance, while below 300 ft. span length the rules of design and construction may be standardized. Perhaps the matter may be stated in another way: The bridge designer needs freedom in developing his general conception and in working out the specific designing problems, if his work is to be efficient and economical; but for spans of moderate length it is considered permissible to deprive him of this freedom.

Since the days when the first engineering specifications to control the designing and detailing of steel bridges came into use, no equally weighty admission of the impossibility of circumscribing engineering design by specifications has come to notice. The 300-ft. limitation is, in fact, a most valuable reminder of the essential difference between specifying for material and specifying for engineering design—the latter ever involving the danger of defeating its own purpose and tending to replace responsible engineering thought by routine processes of copying and piecing together elements of design created by others for prior uses.

In considering the limitation of size to which the new specification is to be applied, one is inevitably led to the reflection that, after all, principles of good design apply with precisely the same force to a large structure as to one of lesser magnitude. Conversely, what is a bad detail or bad arrangement in a small structure is very likely to be similarly defective when applied to a large structure, if the nature of its shortcomings of service is correctly understood—if, for example, it is appreciated that the objection to suspended floorbeams depends upon the relation between traffic loads and the dead weight of the suspended parts. It must, therefore, be possible to set down controlling principles that have an application unrestricted by span length.

At this very point lies a question which the new specification for the first time brings up, and at the same time answers. The question is whether an engineering specification (*not* one that is to govern construction or contract work) should go farther than to state general principles; in this case whether a sound bridge specification can or ought go beyond the line of principles applicable to *all* steel railway bridge construction, regardless of limitations of size. With the adoption of the new document railway bridge engineers throughout the country have answered this question in the affirmative. But the final answer can come only from the test of time and service.

Location and Structures of a Heavy Industrial Railway

Clairton Branch of Monongahela Southern — Tunnel Through Old Coal Workings — Deep Rock Cuts — Retaining Wall Sixty Feet High—Large Arch Culverts Under High Fills—Special Bridge Floors

AN IMPORTANT step forward in the organization of steel production is represented by two costly undertakings recently carried out by the Carnegie Steel Co.: A byproduct coke plant at Clairton, 20 mi. south of Pittsburgh, and a new railroad to serve as direct supply route for distributing the coke made at this plant to the company's blast furnaces in the Monongahela Valley. The latter enterprise, a branch of the Monongahela Southern R.R., operated by the Union R.R. Co., is a piece of railway engineering remarkable alike in its conception and in the line-location and construction involved. The railroad, 5 mi. long, is just approaching completion, though temporary single-track operation started in April, 1919.

While the railroad will carry a very heavy traffic, it has grades of 1.25 per cent in one direction and 1.43 per cent in the other, a fact sufficient to indicate that the conditions governing the location were decidedly unusual. Further, though the line is double-tracked, it has at one end a quarter-mile length of single track, complicated by several spur-track crossings, another result of the severe limitations imposed by local conditions. Correspondingly, the difficulties met in design and construction were of a kind to make the line highly interesting to engineers. An 1,800-ft. tunnel, rock cuts up to 100 ft. deep, and a number of structures of quite remarkable proportions, including road culverts under high fills, a retaining wall 60 ft. high, and several difficult bridges were necessary. There were many interesting detail problems of engineering, a number of which are dealt with in the present article.

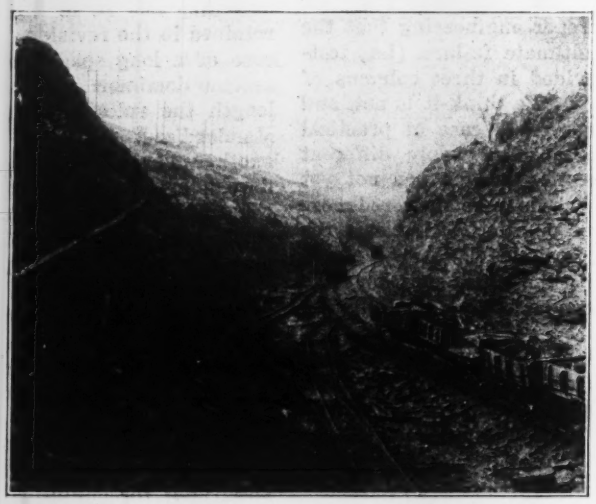


FIG. 1. A HEAVY ROCK CUT OF THE CLAIRTON BRANCH
North from Coal Valley Bridge—Temporary operating track 4 to 10 ft. above final grade.

Coke Transportation and the Railroad Situation

Though carried out as a war enterprise, the new railroad bases on purely peace-time plans of development. A central byproduct coke plant in the Pittsburgh district had been projected by the Carnegie Steel Co. some years ago, to serve its various works, and on search for a location the Clairton site was fixed upon. A river flat adjoining the Clairton steel plant, previously acquired by the company, gave ample room for the coke ovens, and the hillside afforded room for expansion of the town associated with the works. The critical importance of benzol in munitions production hastened the execution of the project, construction of the coke works being begun in August, 1916. The railroad connection, necessary to serve the plant more efficiently, was started soon after. The contract was let in September of the following year, and the work was pushed to completion in about two years, and to the point of operation in eighteen months, despite extreme difficulties of material and labor supply and the absence of priority orders from the Government.

To make the situation intelligible, the railroad conditions must be reviewed, in brief. The Union R.R. is the interplant supply artery of the Carnegie Steel Co. in the Monongahela Valley; it distributes all material moving into or out of the several manufacturing plants from and to the several railroads of the district. In Fig. 2, a small-scale railroad map of the southern part of the Pittsburgh district, the Union R.R. is seen to be a short stem with various spur ends, or branches, connecting to the principal plants of the company and to all the railroads of the district. It includes two bridges over the Monongahela River, at Homestead (to the Carrie furnaces) and at Port Perry, leading northward to the Bessemer & Lake Erie R.R.

When the Carnegie Steel Co. decided to supplement the transportation of its ore supply between Lake Erie and the Pittsburgh district it acquired a controlling interest in the Pittsburgh, Shenango & Lake Erie R.R., a cheaply constructed and poorly equipped line between Conneaut Harbor on Lake Erie and Butler, Pa., about 42 mi. north of the Monongahela River at Bessemer. In the spring of 1896 a new line, the Butler & Pittsburgh R.R., was located between Butler and Bessemer, and this road was ready for operation in the fall of 1897. Meantime, the Butler & Pittsburgh R.R. and the Pittsburgh, Shenango & Lake Erie R.R. had been consolidated as the Pittsburgh, Bessemer & Lake Erie R.R. The southern operating terminus was established at North Bessemer, 4 mi. south of the Allegheny River, while the 8 mi. through the divide and south to Bessemer on the Monongahela were leased to and are operated by the Union R.R.

Development of System

In 1901-2 the Bessemer & Lake Erie R.R. was located and built to provide a better location for a part of the Pittsburgh, Bessemer & Lake Erie R.R. near Greenville, Pa., and the latter was leased and has since been operated by the Bessemer & Lake Erie R.R. Co., which accounts for the change in name. This line is a means for bringing ore from the Lakes to Pittsburgh and taking coal to the Lakes, besides handling a large miscellaneous tonnage. Over this line Lake Superior ore reaches the company's 27 furnaces in the Monongahela Valley, at Braddock, Homestead, Duquesne and Clairton.

Following the establishing of direct connection to Lake Erie, another line was projected and located in 1897-8 to provide direct connection with the coal territory to the south. This is the Monongahela Southern, which is a subsidiary of the Union R.R., from which it starts near Duquesne. Although the line was located as above stated, and some right-of-way secured, none of the line was constructed and put into operation until 1906, when 7 mi. of the line from near Duquesne to Mifflin Junction were completed, and connection made with a branch of the Pittsburgh & West Virginia R.R. (formerly Wabash Pittsburgh Terminal) and through it to the West Side Belt R.R., and later the Montour R.R., all three of these lines having developed from a rather intricate series of railroad projects involving several groups of interest. All of these lines deliver coal for Lake Erie to the Bessemer & Lake Erie R.R. through the Union R.R.

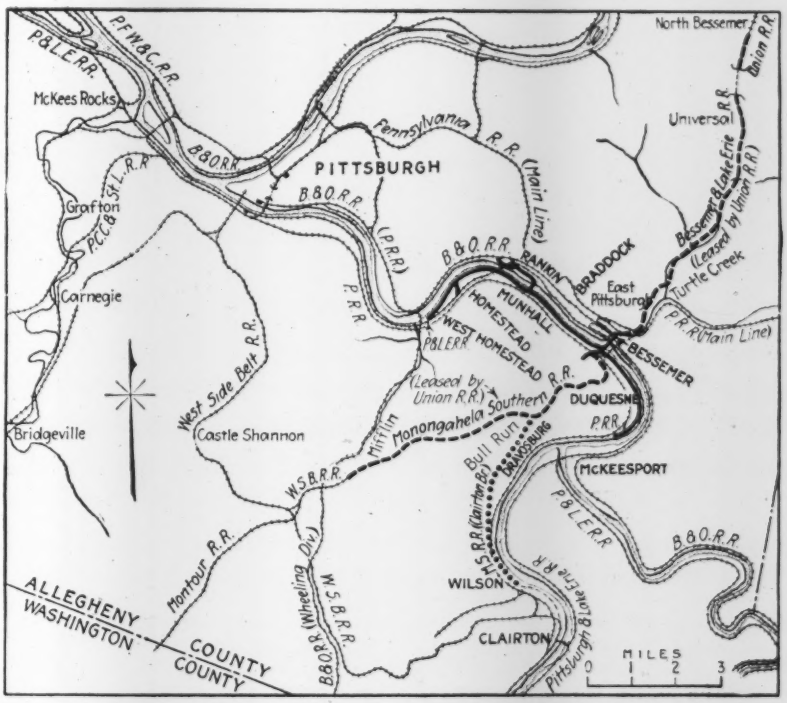


FIG. 2. RELATION OF UNION R.R. TO ORE AND COAL SUPPLY LINES AND STEEL PLANTS

The Monongahela Southern R.R. does not now, and never did, operate trains or own equipment. Under its charter it has located, built and made ready for operation approximately 7 mi. of railroad to Mifflin Junction, and is now completing the Clairton Branch, about 5 mi. long. As soon as built its lines are taken over under long lease by the Union R.R., and from an operating point of view it becomes an integral part of the Union R.R.

By way of Mifflin Junction and the West Side Belt R.R., a round-about route connecting the Union R,R with Clairton was available, but at the cost of a 450-ft. summit climb and 1.6 per cent grade, in addition to more than double the length of haul. Although there existed two riverbank railroads, parts of important trunk lines, these were compelled to make district rates which, for Clairton coke, were so high as to neutralize largely the essential advantages of the entire project. Further, with the coke plant in full operation, enough new traffic will be imposed on the Clairton-Duquesne section to account for almost the full capacity of two tracks, so that the additional carrying capacity of the new line was logically called for.

When the problem of distributing the Clairton coke was first studied, transportation by river received consideration, but met the objection of excessive breakage. Moreover, the traffic other than coke is of a complex character, for which the river would not altogether serve. Coke, the important commodity outbound from Clairton, and ore and limestone inbound, will be supplemented by large amounts of slag and waste or refuse material. The total of these wastes from the plants along the line of the Union R.R. amounts to over 4,000,000 tons per year. There is no longer any space for disposing of this material along the river banks, and it must be carried to the hill-top valleys, where provision for its disposal has been made. The new line will participate in the disposal service. Considering its short length and the comparatively not unusual quantities, the construction of the line has been accomplished only at what might be considered excessive cost. Several factors aside from the results of war conditions combined to make this so. By reference to the profile it will be observed that practically all the excavated material north of the center of the tunnel had to be disposed of as waste, and was in this case transported several miles by standard-gage facilities. Also the excessive length and amount of material in the south approach to the tunnel and the unusual features connected with its disposition at the Curry Hollow fill, to be referred to later, added to this unusual expense. Possibly the most important of all, however, was the large mass of heavy rock excavation necessary to be removed at Coal Valley Cut in close proximity and above the elevation of the Pennsylvania R.R., in such way as to safeguard its operations. These made necessary the use of special devices, including cable inclines and subsequently switch backs and temporary trestles involving crossing over the Pennsylvania R.R. and the highway at Coal Valley for the deposit of a large proportion of this excavated material in the fill approaching the Coal Valley bridge from the South. The total excavation on the line amounted to approximately a million and a half cubic yards. The material excavated was largely the weak shale in the Pittsburgh district, although much of it in the larger cuts was a hard and tough rock interspersed with softer layers, making breakage very uncertain, resulting in frequent delays. The property for the right-of-way cost upward of $200,000, which is considered a reasonable amount in view of the land values generally obtaining in the district.

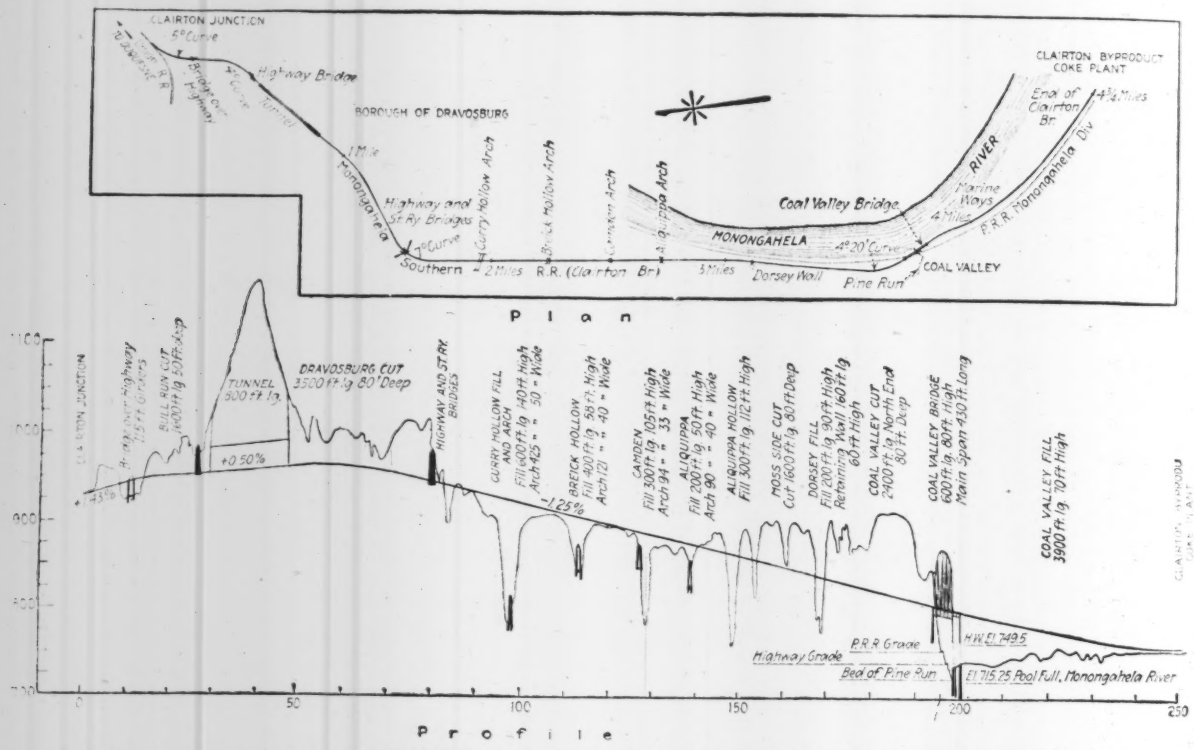


FIG. 3. ALIGNMENT AND PROFILE OF THE CLAIRTON BRANCH, MONONGAHELA SOUTHERN R.R.

In determining upon the most feasible means of connecting the Clairton operations of the company with its other plants lower down the Monongahela Valley through the medium of the Union R.R., at least three alternative routes were to be considered:

(a) A low-grade line paralleling the Pennsylvania R.R. along its upper side, since there was no room much of the way on the lower or river side from Clairton to Duquesne. This would have involved difficult hillside construction for the entire length immediately above the existing railroad and through the quite densely built-up portions of Dravosburg and of the City of Duquesne, it being out of the question to pass this traffic over a line constructed through the manufacturing property of the company at Duquesne. Also such a route presented little or no opportunities for the development of yards or other necessary facilities of like nature. These difficulties seemed to make this line prohibitive.

(b) An open-cut route paralleling the West Side Belt for a short distance, thence by Lewis Run to Mifflin Summit, the present terminus of the Monongahela Southern. This involved grades to overcome the summit of at least 1.6 per cent in both directions and an excessive summit elevation amounting to some 250 ft. over and above the line which was adopted. This also

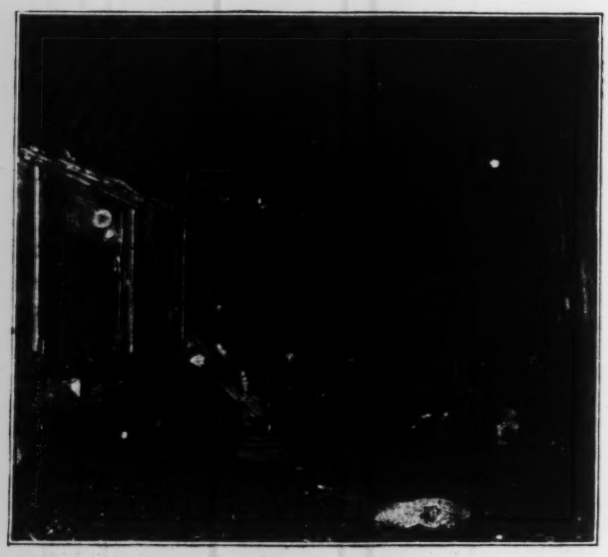


FIG. 4. STEAM SHOVEL MUCKING BENCH EXCAVATION IN SUMMIT TUNNEL; LINE IN OPERATION THREE MONTHS LATER

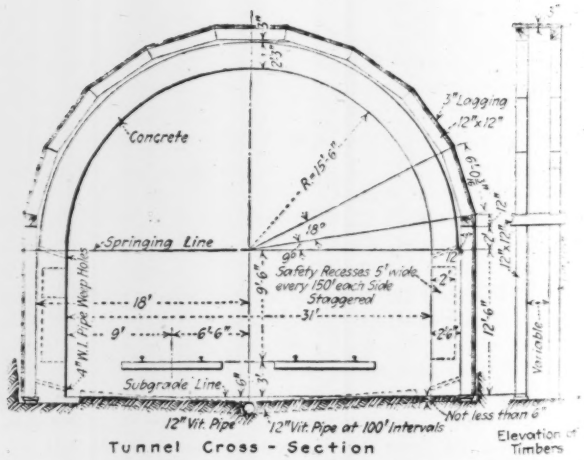


FIG. 5. TUNNEL CROSS-SECTION AND TIMBERING

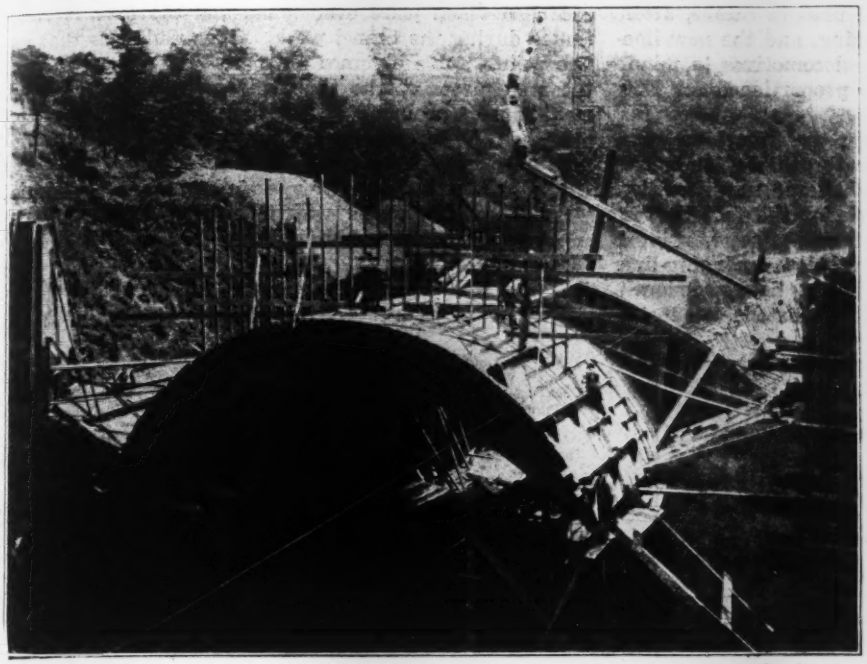


FIG. 6. FORMS IN PLACE FOR CURRY HOLLOW CULVERT ARCH

would have added about 5 mi. to the length of the haul.

(c) An intermediate line necessitating the tunneling of the ridge between the valley followed by the old line and the river. This alternative was adopted, and the route selected afforded the shortest possible length of new line with a controlling grade not in excess of other ruling grades already existing on the Union R.R.

In order to improve the alignment further in the neighborhood of the tunnel and to avoid a cemetery, the line through the ridge was fixed at an angle of about 45 per cent with the axis of the ridge, which resulted in lengthening the tunnel from an originally proposed 1,400 ft. to 1,800 ft. as constructed. From near the tunnel summit the line, therefore, drops on a 1¼ per cent gradiant to the river flat at the Clairton plant. Its alignment and profile are given in Fig. 3.

Details of location were fixed by judgment. A general consideration was that it was preferred to keep the railroad cuts just far enough in from the hillside, at the spurs, to avoid risk of interfering with the Pennsylvania R.R. tracks and the highway below. Considerable increase in excavation was necessary to do this, but it served to avoid much risk of damage, both during construction and in subsequent operation. Subject to this controlling idea and the desire to keep the profile unbroken in order to limit the ruling grade, the character of the line was dictated by the topography, which made it necessary to cross sharp gullies and cut through spurs on account of the impracticability of running around them. At hollows, fills were chosen in preference to trestles, in order to reduce maintenance costs, and to equalize quantities.

A high rate of grade compensation for curvature was used; namely, 0.04 per cent per degree. The roadbed was built 40 ft. wide. The track is constructed with oak ties, tie-plates, and 100-lb. rails, except on the north approach grade to the tunnel, where 130-lb. rail is used. It was desired to have ballasted track on all bridges, but an undercrossing near the north end of the line was so limited in floor depth as to make ballasting impossible. However, concrete-slab floor construction was vital, as hot slag will be transported, and possibly at some time ladles of molten iron.

In connection with this construction it should be said that the power used now on the line is relatively light, locomotives being limited to 125 tons on four driving axles, just as used twenty years ago. The restriction is due to the limited floor capacity of the Monongahela River bridge at Port Perry. However, it is believed

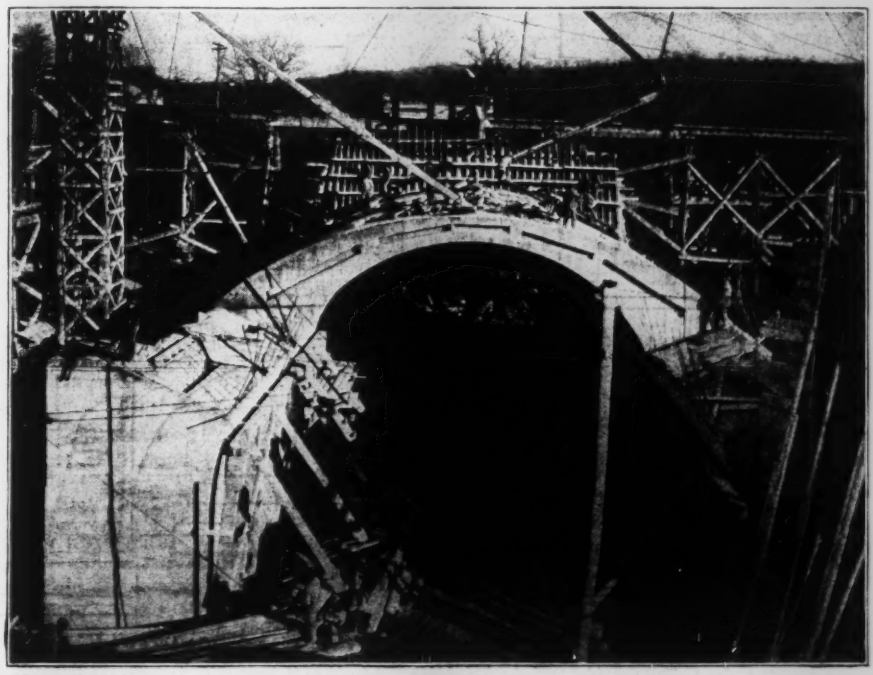
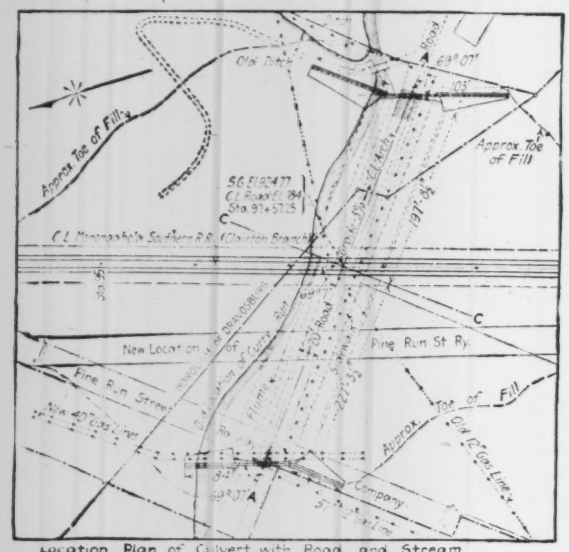


FIG. 7. COMPLETED SECTION OF CONCRETE ARCH, CURRY HOLLOW CULVERT

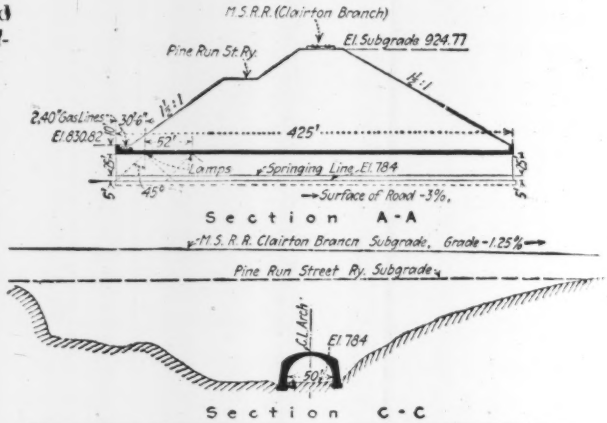
that much heavier power will be used in future, after reconstruction of that river crossing, and the new line has been planned with maximum locomotives in mind. Correspondingly, the bridges are proportioned for E60 train loading.

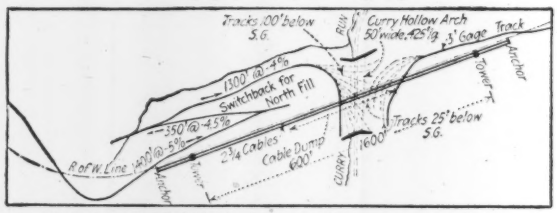
While the shale encountered in the tunnel and the approach cuts was soft, frequently thinly laminated and much broken, it would have offered no difficulties worthy of note in driving except for the fact that it was cut by a great many old coal-mine workings. These were located chiefly at or below springing-line level of the arch. The workings having been abandoned long ago and being poorly supported, extensive subsidence had taken place over them, and the process continued during the tunnel work. One result was that at two points, for a distance of 12 or 15 ft. in each case the arch pieces of the timbering were forced down a maximum of about 12 in., so that they had to be cut out when the concrete lining was being placed, in order not to weaken the ring.

Large amounts of water draining from the mine workings made unusual attention to drainage necessary in the tunnel. This drainage is all taken by weep-



Location Plan of Culvert with Road and Stream





Arrangement of Switchbacks and Cable Dump for Filling

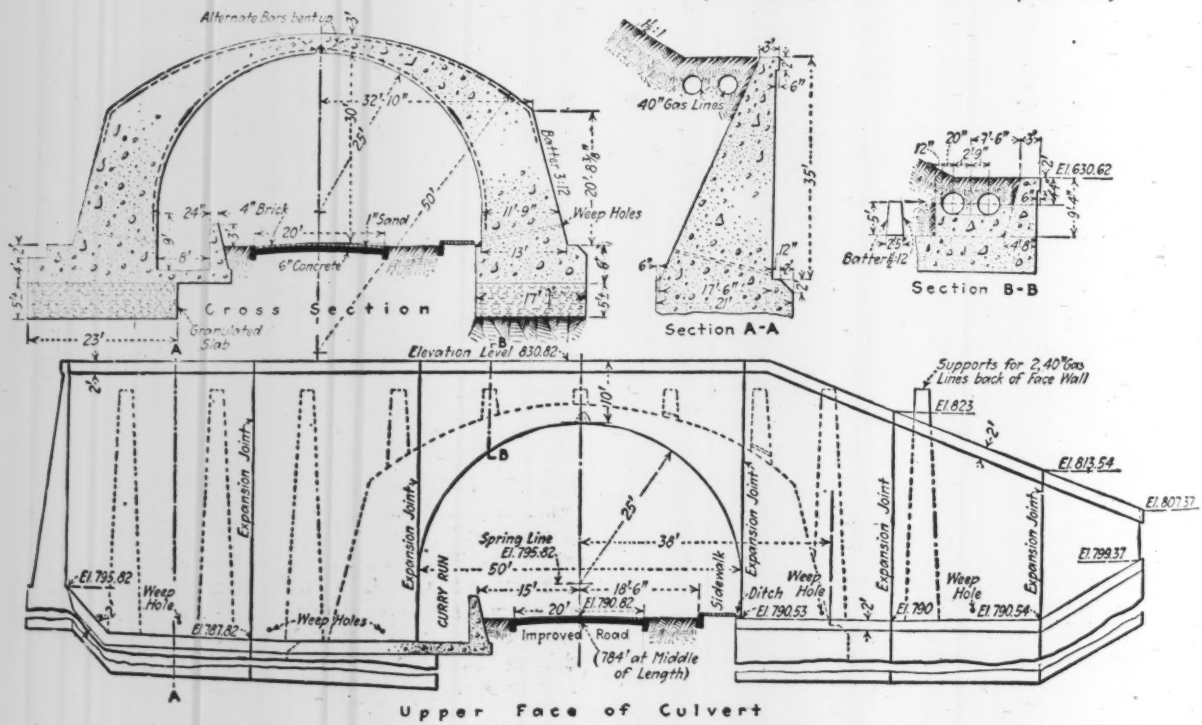


FIG. 8. CURRY HOLLOW ARCH AND FILL, WITH SKETCH OF SWITCHBACK AND SUSPENSION-BRIDGE FILLING SYSTEM

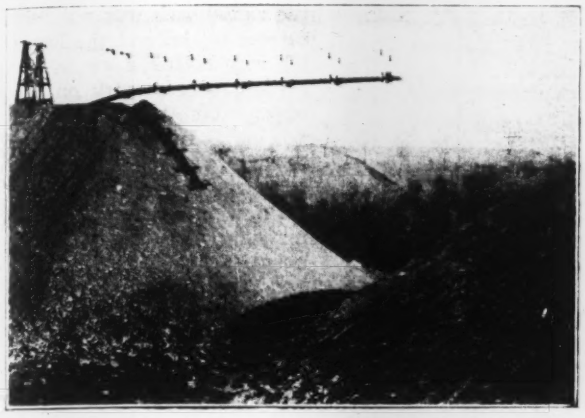


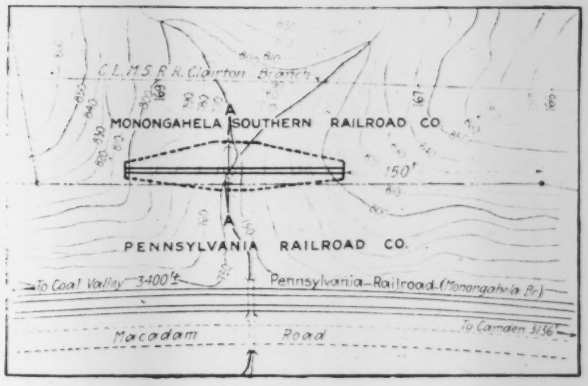
FIG. 9. PROGRESS OF FILLING FROM SUSPENSION BRIDGE, CURRY HOLLOW ARCH; TOES OF NORTH AND SOUTH FILLS MEETING

holes, the lower set located just above floor line. To avoid letting the water get into the tunnel roadbed and thereby keeping this in water-logged condition, all weepers that have more than a drip of water coming from them are piped to 12-in. tile drains laid below subgrade along either wall.

The tunnel was driven by top heading. The greater part of the bench was removed by steam shovel, operated by compressed air (Fig. 4). On account of the length of time that was required for the approach cuts, bench excavation was not started until the heading was holed through. The arch timbering in the heading was supported on a continuous wall plate, and in taking out the bench this wall plate was either underpinned by plumb posts or (where the shelf of rock under it was sound enough) allowed to rest on undisturbed rock. The arch was lagged throughout, and through a large part of the tunnel the posts were lagged also. The tunnel section is given by Fig. 5.

Most interesting among the items of the tunnel construction was the concreting, which was done by a traveling form equipped in an unusual way. A cross-traveling crane supported just underneath the arch of the form hoisted the concrete buckets brought in on cars from the mixing plant at the mouth of the tunnel, and dumped the buckets into the side form either on the side of the supply track, or, after cross-traveling, on the other side over the operating track. This arrangement was used because, as the lining work was carried on while one track of the railway was already in operation, only one side of the form was accessible for direct hoisting of buckets. Remarkably regular and rapid progress was made with this plant. For months at a time, 90 ft. of lining—three 30-ft. sections—was completed weekly. This includes both ends, two traveling forms having been provided in order to hasten the work to completion. Records of 4,300 cu.yd. placed per month were made. The addition of the cross-traveler to the form was suggested by James A. Hart, president of the contracting firm that carried out the line construction, Gillespie-Hart Co.; the form was built by the Blaw-Knox Co.

In the approach cuts to the tunnel, old mine workings a short distance above subgrade level, also caused



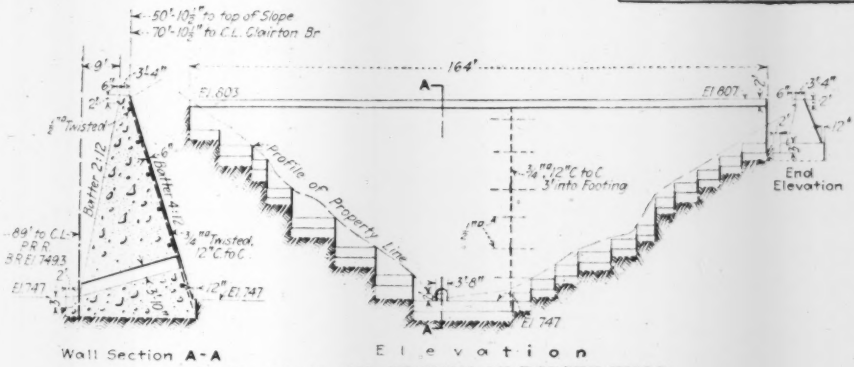


FIG. 11. PLAN AND SECTION OF DORSEY WALL

trouble, chiefly in making the breakage more irregular and in requiring the provision of ample slopes of the overburden to avoid caving due to subsidence.

As it was expected from the beginning that a considerable amount of rock of uncertain character would be found in the cuts, the slope stakes were set for side slopes of 1:1, starting from the roadside ditches. During con-

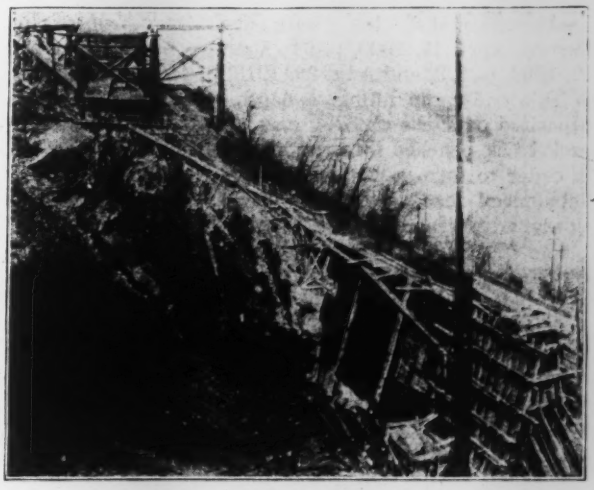


FIG. 10. DORSEY RETAINING WALL, 60 FT. HIGH, UNDER CONSTRUCTION

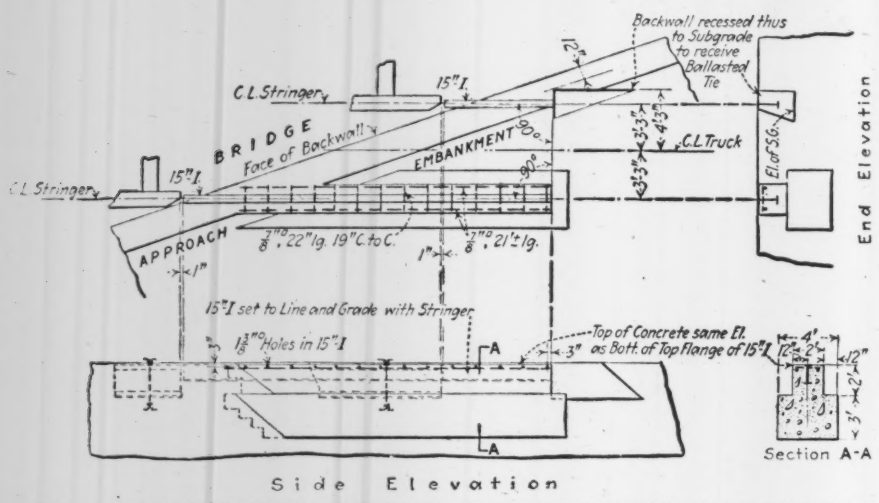


FIG. 13. RAIL-SUPPORT EXTENSION OF CLAIRTON JUNCTION UNDERCROSSING

struction the earth overlying the rock was taken out to these slope stakes, and subsequently the rock was excavated and allowed to stand on whatever contour proved stable. This left a berm on top of the rock which proved convenient as a bench for the spoil track and which also tends to safeguard the earth slope against caving due to movements of the rock.

An unusual structure, at the crossing of Curry Hollow, just south of Dravosburg, developed a history of considerable interest. This hollow is about 600 ft. wide at approximately 40 ft. below subgrade level, and is of sharp V-shape, carrying a road and a brook 140 ft. below. To pass the road and brook through the railroad fill, a concrete arch culvert 50 ft. wide in the clear and 425 ft. long was built, of uniform cross-section (shown in Fig. 8; see also the views in Figs. 6 and 7) conforming to prior heavy railroad tunnel and underpass work. The section of the culvert was developed from experience, and was assumed to be adequate for carrying an overburden of practically indefinite height, and therefore calculations of earth pressures and stresses were not attempted. In making the fill approaching the arch from the north, the suspension-bridge method of end-dump deposition was followed, as used for several large fills on the Hopatcong and Summit cutoffs of the Lackawanna R.R. ten years ago (see *Engineering Record*, April 17, 1909, p. 54; *Engineering News*, April 22, 1909, p. 423, and Aug. 28, 1913, p. 410). In advance of this end-dump filling, a depth of 10 ft. of fill was deposited over the arch by cars operating on a switchback track benched into the hillside (shown in Fig. 8), in order to form a cushion sufficient to equilibrate any unbalanced loading on the structure caused by the slowly advancing fill (see Fig. 9).

The north fill was started first. When its toe approached within 40 or 50 ft. of the north abutment wall, movements in the first or lower filling near the arch were observed; the advancing high fill settled into the lower fill, already in place, and plowed it up into a ridge ahead of the toe. This ridge became more pronounced as the fill moved forward, so much so that it became evident that the distortion would probably extend to the arch structure if allowed to continue.

A small steam shovel was therefore used to cut off the toe of the upper fill and dump it ahead, so as to place additional filling on the lower fill. In addition, the switchback was put into service again, and the lower fill was raised 8 or 10 ft. higher, before work on the upper fill was advanced further. In the meantime the fill south of the arch was being made by dumping from a track, in the usual manner; this dump track, about 20 ft. below subgrade and approximately parallel to the center line of the arch, was moved forward as the fill advanced north.

As the toes of the two fills approached the respective abutment walls of the culvert, the concentrated pressure of the high fill produced some distortion in the concrete structure. The extreme pressure did not occur at points directly opposite each other, on account of the skew of the culvert and the different filling methods used on the north and south sides. Slight cracks in the concrete showed in the intrados at the haunch, at the points where the fill was farthest advanced.

From the earliest indication of unbalanced pressure in the fill a rigid daily survey system was instituted, and this continued until the fill was completed and stability assured. By accurate levels and horizontal measurements, record of the effects of the filling work on the arch was kept, and the distribution of filling was regulated accordingly. With the precautions above described the fill was carried to completion with no further damage than the small cracks mentioned, and these were repaired later to restore the unbroken surface. While direct vertical settlement of the high fills continued after they met, the concentrated slope pressures ceased and there was no further evidence of unequal pressure on the arch.

In connection with this movement, it is important to refer to the foundations of the arch, which are not shown in Fig. 8. The south abutment was carried to rock, about 10 ft. below ground surface. At the north abutment, however, rock lay about 20 ft. deeper; the time required to go down to rock here was a critical consideration, as it became evident that Curry Hollow fill would be the determining section of the whole line as to date of completion and any loss of time here would delay the beginning of traffic operation correspondingly. The soil found at 10-ft. depth was firm, and appeared in every way adequate as a foundation material, so that it was decided to carry the abutment on this soil after widening the foundation to increase the bearing area.

The arch was built in sections 30 ft. long, with expansion joints continuous through footings, bench walls and arch ring, so that the structure was made up of a series of independent arches. The wingwalls were also built in independent sections.

However, with the south abutment on rock even with the north abutment foundation spread over a much larger but more compressible bearing surface some differential settlement was expected. Nevertheless, considerable dependence was placed in the steel reinforcement of the arch to care for the stresses that might thus result, and from the known cementitious property

of granulated slag it was thought that a selected foundation layer of this material wetted and well rammed in place would practically reach its limit of compressibility under the load of the arch itself before the key was cast and would tend to reduce the possible unequal stresses and gradually set up hard before full load was applied without undue settlement of the completed arch. Accordingly, a layer of this material was carefully placed and compacted in the foundation pits, but contrary to expectations a most remarkable degree of settlement occurred under the application of the full load upon the arch.

During the entire filling operation the culvert settled under the increasing load placed upon it, the movement always being greatest near midlength of the structure. There were many irregularities in this movement, but it was always in general accord with the distribution of load. The final figures, after completion of the entire fill, were 9 in. settlement for the south abutment, 11½ in. for the north abutment, and about 10 in. for the crown; all these figures being at the point of maximum settlement, virtually at midlength of the culvert. The abutment figures refer to points established on the sidewalls at springing line, 5 ft. above the floor. In addition, it should be said that in the zones of initial cracking of the inner face of the arch barrel, a system of branching cracks, chiefly longitudinal, still existed after completion of the work, the worst cracks being open ¼ to ½ in.

When the fill was completed, the cracks and a number of small loose sections were cut out and filled with mortar. Similar patching, somewhat more extensive, was required at the south wing of the west face wall of the culvert, which wing, being founded directly on rock, tore loose from the arch barrel during the settlement. In general, no attempt was made to level up the offsets that developed at the transverse construction joints of the culvert due to the 30-ft. sections settling as individual units and cracking chips at some points from the keys in the joint faces (shown in the view Fig. 7).

From observations during this filling work, Mr. Brown states, the correctness of well-established good practice was abundantly confirned; namely, that any end-dumping method of filling for loading large culverts with high embankment overburden is attended by grave danger to the underpass structure, and should generally be avoided.

Three other arch culverts, carrying fills of heights from 40 to 60 ft., a short distance south of the Curry Hollow fill, gave no difficulties of any kind during construction. The largest of these structures is 40 ft. in span; all of them are founded on rock, and all filling was dumped from trestles and deposited symmetrically with respect to the arches.

Near the south end of the line, just before emerging on the neck of the Clairton flat, the line crosses the junction point of two narrow gullies which slope sharply down toward the river bank. To carry the railroad fill across, a retaining wall 60 ft. high from rock foundation to top was built, carrying a surcharge of 40-ft. height of railroad embankment above its top (Fig. 10).

The effect of the funnel shape of the gully was not definitely known; it was thought that, while the convergence might tend to relieve the earth pressure on the wall, it might possibly increase this pressure by concentration. The analysis of the earth pressure conditions was therefore carried on with particular care, and unusually liberal proportions were adopted for the wall, the more readily as the wall is not long and the extra yardage involved was therefore small. A face batter of 2 in 12 and a back batter of 4 in 12 were chosen (Fig. 11), making the thickness of the wall at any section something more than half the height above that point. Vertical reinforcing rods were placed in the back, partly as a precaution against shrinkage and partly to protect against possible shear failure on a weak seam through the concrete. The back of the wall was waterproofed with bituminous paint, as were also the backs of all the arch culverts on the line.

Stepped Drop Flume for Brook

Another concrete structure on the line representing rather unusual design is a drop flume carrying the upper end of a small creek, Bull Run, near the north approach to the tunnel. Here the railroad cuts across a road and the old bed of the stream alongside; the road is carried across the cut on a bridge, while the brook is taken into a concrete-lined ditch at one side of the railway roadbed and carried along to a point where it could be delivered to its original discharge channel below railway level. For bringing the stream down the 20-ft. descent of the bank from its upper

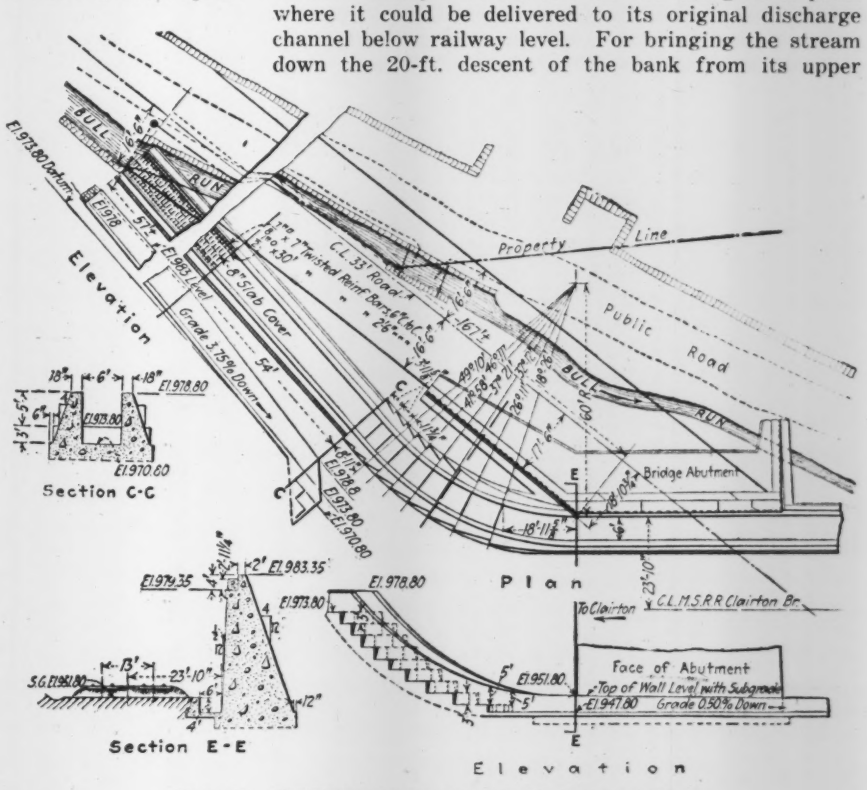


FIG. 12. STEPPED DROP FLUME OF BULL RUN

course to the railway ditch, the stepped channel (Fig. 12) was built. The principle used is one familiar in Western irrigation canal practice. The development of the details of the sidewalks is such as to bring the general contour of the structure in the slope of the earth and shale bank of the cut.

Bridge-Floor Problems

The line contains only two bridges, but circumstances make both of these very unusual structures. Most notable by far is the 430-ft. through-truss span across Coal Valley near the south end of the line, crossing a road, the double-track (and possibly in future four-track) line of the Pennsylvania R.R., and the channel of Pine Run. The structure itself was described in *Engineering News-Record* of Oct. 2, 1919, p. 656.

At the north end of the bridge the face of the rock cliff is sharply oblique to the railway center line, but it was desired to have the end of the bridge square. The cliff was therefore cut back in a long triangular bench to take the bridge seats. In consequence, nearly two panel-lengths of the west truss of the bridge extend over bedrock. The south end of the span, however, is supported on a concrete pier founded on rock 30 ft. below valley bottom, so that the pier is about 85 ft. high from foundation to bridge seat.

The end of the approach embankment south of the bridge is not retained, but its slope is spanned by two 85-ft. plate-girder spans. The abutment, at the shoulder of the embankment, is in appearance a simple dwarf abutment block seated in the fill, but in reality it is a pier penetrating the full depth of the fill and 45 ft. into the natural ground below, with roughly 105 ft. total height, including backwall. The wisdom of going to great care in providing a reliable foundation at this point was shown, during the filling of the approach embankment, by a remarkable slump or subsidence of a 400-ft. length of the embankment immediately south of the abutment. Without warning, the embankment dropped vertically 20 to 25 ft., apparently by breaking through the upper crust of the river flat and squeezing out of place a subaqueous stratum of soft clay or mud.

Solid concrete-slab construction is used for the deck of the truss and girder spans, and curbs about 12 in. high are carried around the openings where the web members of the truss pass through this floor, and also along the outer edge of the slab (edge of footwalk). The purpose is to make the floor suitable for taking drip and splash from slag or steel ladles.

While the large truss span and its approaches carry a ballasted floor, a tie floor had to be used on a span crossing a highway near the north end of the line, in order to reduce floor depth to a minimum and avoid increasing a grade that already was the maximum of the line. The location of this highway was one of the most troublesome factors in the location of the line near its northerly end. Because of the probable delay and other difficulties, no attempt was made to shift the highway for better adjustment of the crossing, and the heavy grade of 1.43 per cent was accepted in preference.

The crossing being on a skew of 19° 50′, half-through girders 115 ft. long center to center of bearings were required. To reduce the floor depth a center girder was used; this girder is remarkably heavy, weighing 90 tons. The floor is a simple arrangement of floorbeams and stringers, but is 50 in. deep on account of the heavy floorbeams used. On the stringers rest steel ties made of 8-in. 25½-lb. I-beams, spaced [illegible] in. on centers. Drip protection is provided by a rein[illegible] forced-concrete slab 4½ to 5½ in. thick, drained to a trough at one end of the ties, which discharges longitudinally to a downspout at the downgrade end of the bridge. The sides of the slab are raised in order to form curbs.

On account of the sharp skew, special difficulty was apprehended in the way of roughness of track if one end of a tie were carried on the approach fill and the other end on the bridge. To equalize the rigidity of support the concrete extension bearings shown in Fig. 13 were put in. A concrete block is molded under the prolongation of the short rail, and in its top is embedded a 15-in. I-beam, with flange exposed, on which the steel ties are to rest. All expansion requirements are taken care of by the sliding of the ties on the top of this I-beam. The opposite rail is carried across the width of the abutment backwall by a similar I-beam embedded in the concrete. The transition from the last tie supported on these two I-beams to the first tie supported on the approach fill (these latter are wooden ties, while the bridge has steel ties) is square to the line of the track.

While such extremely rigid construction as is obtained through placing steel ties in concrete slab laid directly on steel bridge stringers may not be advisable for high-speed traffic, it is expected to prove satisfactory for the very heavy, slow traffic that will be handled over this bridge.

E. C. Brown of the Carnegie Steel Co. acted as chief engineer; H. L. Gordon was engineer of construction, being succeeded by W. F. Purdy in April, 1919; and the Gillespie-Hart Co. of New York and Pittsburgh was the contractor.

Retarding Jetties Stop Bank Erosion

Jetties which check the current without diverting it or causing destructive eddies are being used for protection against the cutting of banks along the Missouri River. They are composed of concrete piles sunk in the river and carrying wire cables to which are attached trees and brush or A-frames faced with wire netting on the upstream side. In this way the current velocity is so reduced that material in suspension will be deposited and thus build up a bar or shoal where erosion has occurred or is threatened. For this work the Bignell water-jet pile is used (see *Engineering News*, Oct. 8, 1914, p. 726 and May 6, 1915, p. 912). The pile is 20 to 40 ft. long and 16 or 14 in. square, with a central 4-in. pipe extending nearly to the point and having ½-in. laterals 30 in. apart, ending in elbows turned upward along the sides of the pipe. A 2-in. pipe with separate hose connection extends through to the point. In a later design, the 2-in. pipe is omitted and the 4-in. pipe is extended to the point, ending in a 2-in. nozzle. Thus, in addition to the boring jet, there are streams of water flowing upward along the sides of the pile. Some of this work has been done by the Chicago, Burlington & Quincy R.R. near Omaha, Neb., and a number of the jetties have been built at different places by the Woods Brothers Construction Co., Lincoln, Neb.

In principle this construction is similar to the Kellner retarding jetties built of cables and steel spider frames, as described in *Engineering News-Record* of Aug. 28, 1919, p. 410.

Railway Engineering Association Has Active Technical Discussions at Annual Convention

Loading and Impact Features of Bridge Report Questioned, Preceding Adoption — Rail Specifications Approved After Debate — Wider Use of Standards Commended

Definite progress in important technical railroad matters was made at the annual convention of the American Railway Engineering Association at Chicago last week, particularly in the adoption of the new bridge specifications, with only minor changes, and in the adoption of the rail specifications, as recommended. Last year the bridge specifications were referred back to the committee, while the rail specifications have been under consideration since 1915. Chief among other committee reports presented and acted upon were those on track, location, operation, yards and terminals and standardization. While all but the track report represented progress only, the importance of the other committees' studies was emphasized in the discussions, which appeared to indicate the active interest of the association's membership.

A news report of the convention appears on page 643; a summary of the more important technical discussions follows:

Iron and Steel Structures

Adoption of the new bridge specifications was one of the important actions taken, as these have been under consideration for more than two years. The chairman, O. E. Selby (C., C. C. & St. L. Ry.) explained the desirability of final action at this time and the meeting evidently agreed with him, as few important changes were sugested and a number of motions for minor changes either received no support or were voted down. Specifications for erection were not included, and specifications for movable bridges will receive the committee's attention this year.

A 16-ft. width for the clearance diagram was objected to by several speakers, but was adopted after a motion to change this to 15 ft. had been defeated. The committee agreed, however, to include a note explaining that 16 ft. would not be required in new bridges built on old masonry that would not admit of this width without extensive reconstruction.

The E-50 loading as an alternative for E-60 was suggested by E. A. Frink (Seaboard Air Line), but the chairman pointed out that provision is made for lighter loading, while B. R. Leffler (New York Central Lines) pointed to the steady increase in engine and car loads and predicted the general use of heavy engines on low-grade lines as well as on those having heavy grades. Favorable operation of such engines with heavy trains on grades of less than 1 per cent was mentioned by A. F. Robinson (A. T. & S. F. Ry.). That the proposed specifications with provision for E-50 loading would take care of all future requirements was the opinion expressed by A. O. Cunningham (Wabash R.R.), on the ground that it would be impossible to build a locomotive that such a bridge could not carry, owing to the distribution of load over a greater length. Mr. Frink's motion to include the E-50 loading was lost.

Impact loads were discussed by H. T. Welty (New York Central R.R.), particularly as to multiple-track bridges. The specifications provide 90, 80 and 75 per cent of the live load, including impact, for two, three and four tracks loaded, respectively. These figures he proposed to raise to 95, 85 and 80 per cent, but the motion was lost after Prof. F. E. Turneaure (University of Wisconsin) had pointed out the improbability of getting the absolute maximum load on all four tracks simultaneously.

Increase of clear spacing of ties from 4 in. to 6 in. was proposed by F. E. Schall (Lehigh Valley R.R.), but Hunter McDonald (N., C. & St. L. R.R.) pointed out that the 4-in. spacing was to provide for softwood ties on account of the shortage of hardwood. This motion was lost, as was one by W. H. Courtenay (L. & N. R.R.) to strike out the clause requiring rounded ends for through-plate girders. Mr. Leffler (New York Central) pointed out the importance of this construction in the case of derailment of cars. Inclusion of horizontal diagonal bracing in viaduct towers and elimination of specific permission for the welding of minor defects in castings were adopted, on motion of Mr. Courtenay.

In addition to the specifications, the committee's report included a new column formula of the straight line type, as a substitute for that of the parabolic type submitted last year. It has the advantage of being applicable to more higher values of I/R. Another appendix dealt with the reasons for continuing the use of the Cooper system of live loading instead of some specific modern engine loading.

Rules for inspection of bridges, trestles and culverts were submitted by the committe on rules and organization and were adopted after some discussion. Such detailed reports were unnecessary in the opinion of Hunter McDonald (N., C. & St. L. R.R.), and might result in loading down the employees with the perfunctory filling in of a number of forms, but it was explained that this filling in of blank spaces was required only to show defects. The committee reported progress in the preparation of rules for the organization of field parties.

New Rail Specifications Adopted

New specifications for rails and recommendations for the location of bolt holes for splices were submitted by the rail committee and were adopted after some discussion. Criticisms of the specifications were submitted by C. W. Gennett, Jr., of Robert W. Hunt & Co. He stated that there was no provision for restricting the production of split heads, although the provisions against "interior defects" would tend to minimize head failures. Since small differences in the carbon content might be greatly overshadowed by later treatment of the steel, he considered it desirable to have one standard carbon requirement for all railroads, to avoid confusion at the mills, and suggested an amount from 0.58 per cent to 0.76 per cent, as this would reconcile the chief differences now existing in a number of specifications without apparent detriment. "The most radical departure from present practice made by this specification," said Mr. Gennet, "is with respect to physical test. Rails

are to be accepted on the basis of elongation only, regardless of the number of test pieces that may be broken under the drop, subject, of course, to the appearance of interior defects. Naturally this annuls the test for brittleness that the impact of the drop has been considered to cover for many years past." He urged modification of the section providing that rails shall be straight in line and surface, stating that slight sweeps were not objectionable and that their acceptance would reduce the gagging materially.

Exception was taken by F. E. Abbott, inspecting engineer of the Lackawanna Steel Co., to the contents of the specification subject to "special agreement." He stated that it might be better to put some of these clauses in another portion of the specification so that there would be no question of whether or not they were binding. If the specification was attached to the contract it would become a part of it and too great power might rest with the inspector. The question of possible additional cost of rail under the new specifications was raised from several quarters and the committee replied that it did not consider this question within its jurisdiction, but that it had been in conference with the steel mills. J. L. Campbell, chief engineer, El Paso & Southwestern R.R., said it had been the experience that rails purchased under the old A. E. R. A. specifications had been subject to somewhat higher price.

For Wider Use of A. R. E. A. Standards

The committee on standardization stated that it was the purpose, through standardization, to reduce cost and to make materials more readily available as needed, as well as to promote cheapness and facility of manufacture. C. A. Morse, chief engineer, Chicago, Rock Island & Pacific R.R., questioned whether general standardization would result in as great development in improvement of designs, as by offering greater opportunity for competition. Mr. Morse said that the most important step for the present would be the general adoption of standard rail sections. It was stated by A. S. Baldwin, vice-president Illinois Central R.R., that more force should be brought to bear on the railroads to adopt the A. R. E. A. standards, and in his opinion, conferences of a railroad company's engineers would find that only very small compromises would be necessary for their adoption, even on large systems. It was suggested by C. W. Baldridge (Santa Fe Ry.) that if the use of these standards was to become general, their adoption should be made only by a vote much greater than a majority. The chairman of the committee replied that it was the purpose of the board of direction not to transmit any specifications or plans until adopted on a sufficient mileage of railroad and until manufacturers had agreed to their use. It was the opinion of Mr. Morse, of the Rock Island, that the new relation of the American Railway Engineering Association with the American Railway Association would probably lead to more definite procedure in the general adoption of A. R. E. A. standards. It was pointed out by Edwin F. Wendt, Interstate Commerce Commission, that consolidations of railroad companies under the new Interstate Commerce law would probably lead to more general standardization.

Concrete Roadbed—Ballast—Ties

Experience with concrete slabs under the ballast on soft roadbed where traffic is heavy indicates that they will give successful result at reasonable expense, according to a resolution submitted by the committee on ballast and adopted without discussion. The report showed that such construction has been in use for several years. R. H. Ford (Rock Island Lines) criticised the definition of ballast in not including its purpose for drainage. Further, he doubted the value of blank forms used by the committee for time study and cost data of ballast work. Specifications for stone ballast were adopted and the committee is preparing plans for the standardization of ballast tools. Comparatively few railways own or operate their own stone-crushing or gravel-washing plants, but the committee listed some recommendations for the design of such plants, including the combined production of material for ballast and for commercial use in order to warrant the installation of a plant of economical size. These recommendations were adopted.

Recommendation of the tie committee for continuance of the tie specifications formulated by the U. S. Railroad Administration led to a sharp discussion, but this was based more on dissatisfaction with the supply obtained than upon the provisions of the specifications themselves. After a careful explanation of the situation by John Foley (Pennsylvania R.R.) the committee's recommendation was adopted. Zinc-treated ties should be allowed to season for from two to six months before being placed in track where track circuits are used, while the number installed annually in any circuit should not exceed 15 per cent of the total number of ties in that circuit. The wood preservation committee also proposed to limit the use of such ties to territory west of a line following approximately the 100-deg. line of latitude, creosoted ties being used east of that limit on account of the greater humidity which is liable to cause leaching of the zinc salts.

As to substitute ties, the tie committee considers that no design suitable for high-speed heavy traffic service has been fully developed, but that some such designs warrant further trial while several would be justified for light traffic lines whenever the relative prices of wood and substitute ties will permit.

Discussions on Track Materials

Active discussion and controversy marked the consideration of the track committee's report. A design for cut spikes was submitted but was criticised by both engineers and manufacturers, the latter claiming that it could not be manufactured by automatic spike machines. Although the chairman stated that such spikes are in use, it was voted, on motion of W. C. Cushing (Pennsylvania Lines) to refer the design back to the committee for further consideration. Similar dispute arose over the specifications for steel tie-plates. F. E. Abbott (Lackawanna Steel Co.) urged that these would exclude soft steel which is easy to punch and is suitable for the purpose, but W. P. Wiltsee (N. & W. R.R.) took the position that the tendency is to require the use of a higher grade of steel.

Designs for clamp frogs led to still further argument, the committee presenting these as information, while several speakers endorsed this type of frog and urged adoption of the designs as recommended practice for inclusion in the "Manual." As the committee wished to give the designs more consideration it objected to their adoption at this time and was sustained by vote of the meeting.

Screw spikes were considered at some length by the tie

committee, which suggested that careful watch be kept of such installations on account of their relation to the life of ties by spike killing. Varying results have been found on different installations aggregating 230 miles of track, unsatisfactory results being due largely to the practice of driving the spike with a hammer before starting to screw it into the tie.

Reinforcing Bars for Concrete

Specific prohibition for twisted bars for the reinforcement of concrete, as provided in the masonry committee's specifications, met with some objection. Hot twisted bars are dangerous, according to T. L. Condron, while Mr. Condron and Prof. A. N. Talbot agreed that cold twisted bars give no advantage over plain or deformed bars commensurate with the extra cost of the twisted bar. A suggestion that the twisting is in itself a test of the good quality of the steel was characterized by Mr. Condron as "salesman's talk." A proposal to limit the probition to hot twisted bars was voted down.

Another proposal, by E. A. Frink, to require reinforcing steel to conform to the specifications for structural steel was defeated, the committee pointing cut that many engineers prefer the harder steel for reinforcement. The committee was sustained on some other points and its specifications were adopted.

Copper-plated bars, copper-alloy bars and a rough enamel coating for bars were suggested by the committee on electricity for use in reinforcing concrete subject to electrolytic action. This was accepted as information without discussion. It was pointed out that in reinforced concrete ships protection has been based upon density and richness of concrete, and high quality of materials and workmanship, while experiments have been made with non-metallic waterproofing paints.

Wages an Element in Railway Improvement

Controversy over the effect of the new wage scale appeared imminent, owing to opposing views presented both by majority and by minority reports of the committee on railway location, but for some reason this point was not touched on in the brief discussion. The majority report predicted a change from slow freight trains of enormous weight to lighter and faster trains, so that grade reductions would be of less importance than the provision of additional running tracks. The minority report pointed out that the railways have contended that even with an eight-hour day and 1½-time pay for overtime it would be more economical to continue present methods than to introduce higher speeds in freight service.

A system of training for young engineers in railway service was outlined by the committee on economics of railway labor, this including a rotation of service to cover field and office work, construction, maintenance, drafting and designing. Appreciation of this work of the committee in the interests of the young engineers was expressed by Prof. S. N. Williams. Educational work of this kind can be divided into development of skill and development of morale of the individual and the forces, according to J. L. Campbell (El Paso & Southwestern Ry.), who considered that the latter is becoming by far the more important in railway engineering service.

The desirability of wider information as to where waters suitable for drinking and boiler purposes may be obtained and how they should be treated was urged by H. T. Douglas (Chicago & Alton R.R.), who emphasized the serious results following the use of bad feed waters in boilers. The water service committee's proposal to withdraw from the "Manual" the matter on water treatment, as not in accord with present conditions, was accepted. Its specifications for wood tanks and wrought iron tank hoops were accepted, but with some amendments by E. A. Frink (Seaboard Air Line), who proposed galvanized hoops as an alternative and pointed out the danger of over-tightening the hoops during construction. The committee's proposed organization for railway water departments was adopted.

Rules for electric lighting for passenger stations were submitted by the committee on buildings. Flood lighting for platforms is rarely desirable. Permanent or portable chemical closets and urinals were recommended for stations where water supply and sewers are not available. The report stated that a number of such devices are in use and that some of them are proving satisfactory both in cost and in the elimination of odor and pollution.

Ashpits of the water type should have sidewalks on the outer side of the tracks and transverse bars between the track rails so that men can walk on the engines without danger of falling into the water. In the committee's opinion the use of floats or rafts over the pits is of questionable value.

Wood Preservation

Additional and revised specifications for creosote oil and the treatment of timber by creosote and zinc processes were submitted by the committee on wood preservation and were adopted. The trial of sodium fluoride was recommended for railways interested in water soluble preservatives. As to tests of treated ties by laying them at any point in the track or in special test sections under careful supervision, the latter is considered preferable. Further, while tabulated records of ties on various roads have been given formerly by the committee, it now proposes to give more detailed records of results on individual roads. In this connection it submitted records of results on the Delaware, Lackawanna & Western R.R.

Management and operation of railway plants for timber treatment came in for severe criticism by the committee, as in many cases they are in the hands of departments which do not comprehend the engineering features and whose main object is quantity production. Reference was made to creosoted piles that have given 29 years' service in the infested waters of San Francisco Bay and are still in good condition. In this connection, lantern slides were exhibited by Lowry Smith (Northern Pacific Ry.) showing the destruction of piles by borers.

That shrinkage of earth fills averages 10 per cent, on a comparison of excavation and fill, while subsidence of the original ground under fills averages 1 per cent per foot of height of fill and is much more extensive than is generally supposed, were the conclusions of the roadway committee. As to the latter, the chairman, Mr. Ambrose, stated in the discussion that the committee had been surprised to find how little engineers appreciated its extent. In this discussion there was evidence of considerable doubt as to whether shrinkage percentages do or do not include subsidence and whether they are based upon excavation quantities or fill quantities.

Practically the only discussion on the report of the

committee on electricity was regarding the proposed loading of 5,000 lb. for wooden poles supporting transmission, telephone and telegraph line crossings of railroad right-of-way. F. D. Hall, electrical engineer, Boston & Maine R.R., questioned this loading in view of the difficulty of getting power, telegraph and telephone companies to conform to it. Edwin B. Katte, chief engineer of electric traction, New York Central R.R. and chairman of the committee, stated that the specifications for crossings, as proposed, conform to those of the American Electric Railway Association. The portions of the report on electrolysis, water power and electrical interference of high-tension lines, were approved and accepted as information. The committee called particular attention to that portion of the water power report describing the power limiting and indicating features of the Rocky Mountain electrification of the Chicago, Milwaukee & St. Paul R.R., a portion of which was inspected by members of the committee last summer. To limit peak load requirements it is necessary to dispatch trains, if possible, so that no more than one heavy train is ascending a heavy grade at the same time.

Conservation of Materials and Human Energy

In the presentation of the report on conservation of natural resources, the committee emphasized the importance of the reclamation of old materials shown by its study of the subject. Careful consideration of that portion of the report concerning the conservation of human energy, with particular reference to the engineering forces of railroads, was commended to the association by S. N. Williams, professor emeritus of civil engineering, Cornell College, Iowa.

Metric System Opposed

Warning as to propaganda to influence Congress to pass a bill making the use of the metric system compulsory and prohibiting the use of the American system under penalty of fine and imprisonment, was given in an address by W. M. Wilson, representing the American Institute of Weights and Measures. He pointed out that the use of the metric system is already legal, and outlined the consequences which its enforced introduction would have on railway departments and manufacturing industries. A resolution was adopted, as presented by W. H. Courtenay (L. & N. R.R.) opposing the forced introduction of the metric system and the exclusion of the American system.

Activated-Sludge Process Considered at London

Authority to visit Manchester, Sheffield and Worcester for the purpose of studying biological methods of sewage treatment, apparently with particular reference to the activated-sludge process, has been requested by the Main Drainage Committee of the London County Council. Studies of the process named were started in the laboratories of the County Council before the war. The committee's report states that since the adoption of chemical precipitation in 1887, the volume of sewage discharged at the two London outfalls has increased from 216,000,000 to 348,000,000 U. S. gal. a day. The pressed sludge conveyed to sea for disposal amounts to about 2,000,000 long tons yearly. The sludge has 92 per cent of moisture and is estimated to contain about 15,000 long tons annually of solid matter.

Timber Clearing in Drainage Districts

IN land drainage development there has been no lack of private money to finance meritorious projects, but if the confidence of the investing public is to be maintained it will be necessary to develop the land in drainage districts as rapidly as it is reclaimed, for an undeveloped district is certain to have difficulty in meeting payments on bonds. This was the view expressed at the annual meeting of the National Drainage Congress by Lewis A. Jones, senior drainage engineer of the U. S. Department of Agriculture. His further discussion, which is given in abstract below, deals with matters which must be considered by engineers for drainage projects, the clearing of timbered land especially being obstacle to rapid development.

On districts having a total area of 5,000,000 acres, it was found that many had less than 10 per cent of the land in cultivation, although drainage improvements had been completed for a number of years. It is questionable if some of these districts will be able to meet their obligations as they become due. The only districts having financial difficulties were those requiring colonization. For all those where the land was owned by abutting property owners the finances were in sound condition.

When drainage was first attempted on a large scale the projects were located in a prairie country where the land was available for cultivation as soon as drained. Where the timber is heavy the clearing is expensive and usually costs more than the drainage. It is slow and laborious work, especially where wet lands must be cleared before field drains can be constructed. The time and cost of clearing have made the rate of development slow. If the settler has not the means to purchase the necessary machinery and hire labor he must develop the land slowly, and it will be some time before he has available for cultivation sufficient land to afford him a living and pay his drainage taxes.

In some drainage districts an attempt has been made to clear the lands before they were sold, but the price usually is so high that these lands are not attractive to settlers with small capital. Promoters of other districts have offered to clear the land for the purchaser for a certain sum per acre or on a percentage basis. In some instances this has proved satisfactory, but there is need for some plan by which the work can be carried on by an organization. One method would be to broaden the powers of the drainage district so that it could clear land for settlers, or a separate organization could be provided for the purpose. In either case the cost should be charged to the land benefited.

Stump and land-clearing districts were provided for in recent bills in Alabama and Minnesota, but both bills failed. The great advantage in such an organization would be that it could purchase powerful machinery that the individual farmer could not afford. The salvage in ties, posts, poles, logs, pulpwood, firewood, etc., would be available in large quantities and machinery for working up this salvage economically might be provided. Experience with drainage districts indicates that when once clearing operations are undertaken on a large scale instead of piecemeal, there will be a great reduction in the cost of the work. If the settler could pay for this work in installments spread over a number of years and drawing a low rate of interest, his prospects would be improved and his lands more attractive.

Strengthening a County Bridge to Carry Motor-Truck Traffic

By Morris Goodkind
Bridge Engineer for Mercer County, New Brunswick, N. J.

INTERESTING problems in bridge design have been encountered in connection with county highway work in Mercer County, N. J., especially in the strengthening of existing bridges. Recently two bridges required strengthening under somewhat unusual circumstances, and the facts of the work may be of interest in a suggestive way to highway and bridge engineers elsewhere.

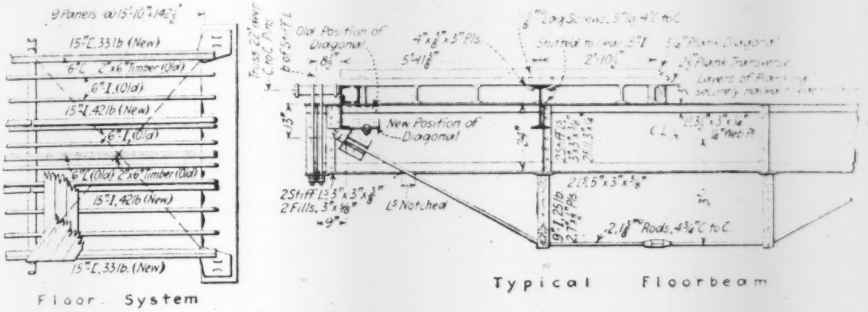


FIG. 1. REINFORCEMENT OF FLOOR BEAMS, STRINGERS AND PLANKING OF COUNTY HIGHWAY BRIDGE TO CARRY MAIN-ROUTE TRAFFIC OF MOTOR TRUCKS

Mercer County has some 1,500 bridges and culverts. These, of course, were built to provide for horse-drawn farm vehicles only, and today, with the advent of the motor truck, any one of these bridges may suddenly be subjected to a gross load of 18 tons.

The almost miraculous development of motor-truck traffic has created a state of extreme anxiety among highway officials. One can readily appreciate that this anxiety is well founded when one realizes the sudden and marked change of loading upon bridges, and the utter recklessness of motor-truck drivers in hitting obviously weak structures at full speed, in spite of cautionary signals. The situation has been fully appreciated in this county, and despite the handicap of limited funds, the problem has been attacked as actively as possible. Many new bridges are built, but money limitations make it necessary to resort to repairing and reinforcing when this will satisfy conditions for the time being.

A few months ago the main artery of motor-truck traffic between New York and Trenton and Philadelphia was cut off by the beginning of state road improvement between Hightstown and Windsor, and the main-route traffic had to be detoured over the Brunswick Pike. Two bridges on this road, near the Mercer-Middlesex County line, had capacities of only four and five tons, respectively. It was necessary to strengthen them in the shortest possible time, without interference to traffic and at the least possible cost. The object was to enable them to carry for a short time an almost continuous traffic of loaded trucks.

On examination it was found that the stringers were stressed well beyond the elastic limit, and that a good many of them had already taken a permanent set. One of the two bridges, of 52-ft. span, had 5-in. I-beam stringers on a 13-ft. panel, while the other, a 142½-ft. span had 6in. I's on a 15-ft.-10-in. panel length. The floor beams also were highly overstressed, and, due to the lack of stiffener angles, they deflected laterally to so great an extent that the web in some cases was 1½ in. out of plumb. The floor, consisting of two layers of white-oak plank totaling 5½ in. in thickness, was in good condition. The trusses were in good condition, and if allowed a unit stress of 23,000 per square inch were capable of carrying a uniform loading of 90 lb. per square foot of floor. The writer considered this unit stress justifiable, because the excessive loading that was to come on the bridge would continue only until the state highway was completed. In the circumstances, the problem was to strengthen the floor framing and maintain traffic at the same time. This was done by the several various changes indicated on the drawing Fig. 1, herewith.

The stringers were replaced by two outside lines of 15-in. channels and two interior lines of 15-in. I-beams, as indicated. The old shallow stringers were left in place, chiefly because their value for further use elsewhere did not warrant incurring the cost of removing and hauling them. They have all taken on a permanent set, and are not counted on as taking load. The two layers of planking were securely spiked to each other so as to act as a single layer, and were fastened to the

FIG. 2. ATTACHMENT OF TRUSS RODS TO FLOORBEAM, AND CONNECTION OF NEW OUTER STRINGER

15-in. stringers by ⅝-in. lagscrews and clips. The planking is thereby made continuous over supports, which brings it up to the capacity of the stringers.

Reinforcement of the floor beams required the use of truss rods. Two 1⅛-in. rods with sleeve nuts form the tension element of the floor-beam trusses; they pass over 9-in. I-beam posts and are connected to the floor-beam and near the ends by clips (see view, Fig. 2).

Tightly fitting stiffener angles were applied to the floor beams in order to correct the twist of the web.

All this work was carried on without interference to traffic. As strengthened, both bridges have a capacity of 12 tons at 16,000 lb. unit stress.

At the time when the long-span bridge was first

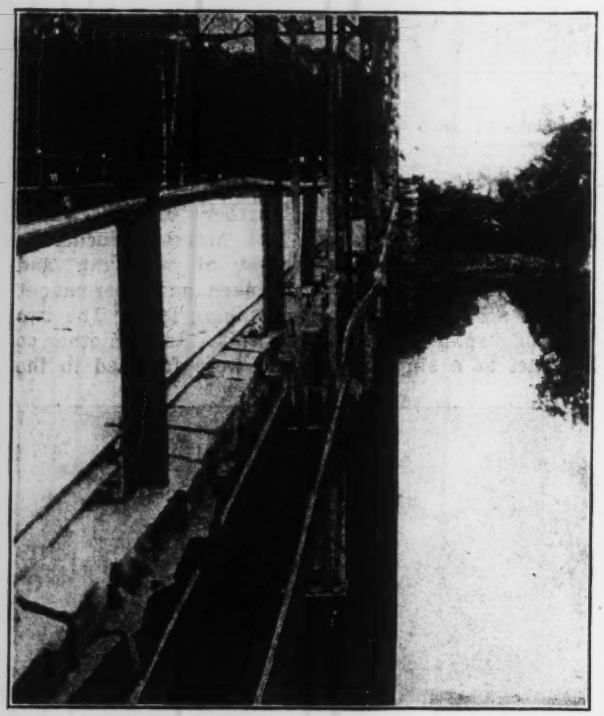


FIG. 3. BUCKLED LOWER-CHORD EYEBAR, 142½-FT. SPAN

examined, the writer noticed a transverse deflection in the eyebars of one panel, amounting to almost 2½ in. (see Fig. 3). It was found on examination that the bridge was set so that it could not expand. There was ample clearance between shoes and abutment backwalls, but the four anchor-bolts of the expansion shoe were tight up against the ends of the slotted holes in the shoe plate on warm days. This condition was corrected by lengthening the slotted holes.

It might be mentioned that numerous instances of restrained expansion are found in highway bridges; the lower-chord eyebars frequently fail to perform their function in warm weather. In some instances this is due to blocking up of the space back of the expansion shoes, by dirt or by concrete placed to incase the shoes. In the present case the shoes were clear, however. The fact that only the outer bar buckled is probably attributable to some slight error of setting.

The effect of the reinforcement is quite noticeable. Formerly the passing of even the lightest vehicles produced annoying rattling, but now the heaviest truck traffic goes over the bridge without appreciable noise.

Lug or Lugless Brick?

—*General Engineer Opinion*

THE National Paving Brick Manufacturers Association, at the New Orleans session of the American Society of Municipal Improvements, introduced, before the brick committee, its proposed new specifications. The two new proposals that appear as the most radical departures are the manufacture of the standard lugless brick and the employment of a plain sand cushion when bituminous fillers are used. *Engineering News-Record* indicated its stand as to the specifications in an editorial published Nov. 13-20, p. 845. A number of letters were sent to secure general engineering opinion upon the new specifications, and answers to these letters follow.

P. K. DE VOE
City Engineer, Creston, Iowa.

While we have had only a small amount of experience with the lugless type of brick, our experience has been very unsatisfactory and the type of paving resulting from its use equally unsatisfactory. The chief complaint we have experienced has been the inability to pour the brick joints with the liquid filler without what we would term "skim plugging." If an attempt is made to open space these lugless bricks it results both in irregular spacing and crooked courses. Also there is a considerable tendency for the brick to rock and to work the cushion sand up between the courses, especially where the sand is wet. We have had a considerable amount of very satisfactory experience both with the wire cut lug and with the pressed lug brick and find that none of the above objections are present in their construction.

I can hardly imagine what might be the motive of standardizing the brick specifications to one type of brick only, unless that motive is selfish, and personally, I have always believed in open competition.

M. W. WATSON
State Highway Engineer, Kansas.

It has been my observation that bituminous filled brick pavements have been successfully constructed in this section of the country by the use of lugless brick, and at the present time we are permitting its use on this type of work, but for grout filled or monolithic construction I cannot concede that the lugless type will prove satisfactory. We are at the present time requiring the use of the lugs which shall not exceed in area one-third of the surface of one side of each brick. I have examined several pieces of pavement construction with grout filler and lugless brick and I found that the grout has not completely filled the space between bricks, and, unquestionably, trouble will be encountered from work of this character. This change is like a great many other things that are advanced without sufficient investigation and experience. The manufacturer sees that by the omission of the lug he can more readily dispose of his culls and thereby reap a greater profit, but as in the case of most other materials, decrease of production cost does not seem to affect the actual price to the ultimate consumer.

In regard to the use of a plain sand cushion, I feel that for bituminous filler in the ordinary case a sand cushion is satisfactory. There are, however, places where the soil is of such a nature that the base will

crack and the sand escape, thus allowing the brick surface to become irregular, in which case the use of a sand cement cushion or a bituminous cushion may be advisable.

We have performed a few experiments on bitumens and sand for cushion and have found that about 5 per cent of Tarvia B or Tarvia K.P. will hold the sand together sufficient to keep it from flowing.

HENRY MAETZEL
Chief Engineer, Dept. Public Service, Columbus, Ohio

I beg to say that with a square-edged, wire-cut lugless brick, the use of a pitch filler appeals to me as very desirable. However, with a repressed lugless block, which we have used in many instances, we have found them so smooth and regular in surface, that, when laid, the spaces between the bricks are insufficient for any but pitch filler, and we think the wire cut lugless brick would present practically the same difficulty. With mastic or grout filler, as well as asphalt, we have found the lug brick desirable since the proper spacing was insured.

As far as the suggested reduction in size of brick is concerned, i.e., changing from 3½ x 4 x 8½ to 3 x 4 x 8½, I am heartily in favor of it, since I think this reduction in *width* will greatly tend to insure more perfect vitrification and produce a better brick. I do not especially approve of this change with the idea in mind of laying brick on the 4 in. concrete surface on light traffic streets or alleys with the 4 in. face exposed to traffic.

Our practice has been, especially during the present high cost of paving, to pave alleys with one course concrete pavements, and I find, in checking up, this style of pavement has cost about 10 per cent less than the suggested brick pavements would, and has in every respect proved satisfactory. In conclusion I might say that we would be glad to specify the changes suggested if same prove satisfactory and feasible in cities where they will be tried, but at present we feel that the claims are not justified, except for pitch filler, and the change in size in so far as greater uniformity and more thorough vitrification will result.

ELLIS R. DUTTON
Assistant City Engineer, Minneapolis, Minn.

The first and principal recommendation for a standard size, lugless, square edge, wire-cut brick, seems to me to be reasonable, proper and one that tends to a reduction of costs in brick paving. There can be no argument as to the standardization of size, as any make of brick can be used interchangeably in the construction and repair of brick pavement. The only question that occurred to me when their use was suggested was whether the filler would penetrate the joint spaces, and prevent a movement of the brick. I investigated this phase before attempting to use such brick and found no difficulty in use of the filler. After use in our own work I am satisfied that the filler can be properly applied. In the use of sand cushion and bituminous filler we have had good results. We have never used any other construction except perhaps a sand filler and sand cushion. As to the reduction of the depth of the concrete base, that is a question entirely aside from the brick, as it would apply equally as well for any top. I do not however, believe in a reduction of the base, but rather in an increase. There are streets of medium or light travel where a reduction in depth of brick could be made without materialy affecting the quality of the pavement. By the use of this standardized brick it can be readily accomplished by laying the brick flat, thereby reducing the cost of the brick approximately 25 per cent.

Summarizing the use of the standardized paving brick will result in: (1) Uniformity, for all manufacturers will make the same size, and thus permit the use of any make of brick, interchangeably. (2) Suitability, permitting the laying of a paving of a depth to suit the traffic needs. (3) Economy, in the manufacturing end, by eliminating many sizes. In use, requiring less filler because of the closer laying of the brick.

There are other reasons for a standardized brick, but the above are some of the principal ones.

GEORGE C. DIEHL
County Engineer, Erie Co., N. Y.

I believe that the best results are obtained when brick with lugs are used. Also, that cement sand-cushion should be used in all cases, and that a brick 3 in. deep is practicable and would greatly decrease the cost of this type of construction.

R. KEITH COMPTON
Chairman and Consulting Engineer, Baltimore Paving Commission

Lugs are absolutely necessary for the proper flow, no matter what filler is used, otherwise improper penetration will follow. More brick pavements in this country have failed due to the use of plain sand cushion than from any other cause. A cement sand bed should be used, no matter what filler, in order to maintain uniform surface. Both of the recommendations of the brick manufacturers' association are, in my judgment, unsound.

W. W. HORNER
Chief of Division of Sewers and Paving, St. Louis, Mo.

I have found the proposed specifications of the paving brick manufacturers objectionable in that they propose the use of a 3 x 4 in. square-edged brick. This means a lugless brick, and therefore a brick of very small spaces of joints for filling. All of our experience has indicated that one of the greatest defects in brick paving has been incomplete joint filling, and this has been particularly true of the cement grouted pavement. In the writer's experience most of the pavements in which the grouted joints have broken have been found to be only partially grouted. The incomplete grouting has been due to either a filling of the bottom of the joints with sand from the sand cushion during rolling, or from the failure of the grout to penetrate to the bottom of the open spaces because of its bridging over the small joints.

That this experience is quite general has been indicated by the increasing use of lugs, and employment of other methods for providing a wide, free space for grout penetration. Most of the development of paving brick in the last 10 yr. has been along this line. That this development has been in the right direction has been indicated clearly by the superior grouting of the modern pavements. For the old flat bricks good grouting was sometimes secured, and many satisfactory pavements resulted, but with the modern lug brick, and especially the wire-cut lug, good grouting is easy to secure and good results are becoming general.

The writer seriously objects to the proposed specifications on the ground that they are ignoring all the

advantges of recent development along this line, and are reverting to a now obsolete standard of paving brick, solely to secure a reduction in the manufacturing costs.

Possibly realizing the difficulty of securing good grouting with the proposed brick, the manufacturers proceed to relegate the cement grout pavement to the position of an alternate specification, and present a preferred specification for the use of an asphalt filler. But then immediately proceed to decrease the probability of securing a good pavement under these specifications by advocating the sand cushion, a thing which has been found to be equally responsible, with poor grouting, for the failure of many of our brick pavements. The writer finds this specification objectionable, as it ties the profession down to one type of paving brick construction, that type involving the use of two factors which have, between them, done more than anything else to create defective pavement. These are the lugless brick and the sand cushion.

In many localities the use of the lug brick and the cement grout and mortar bed has been so satisfactory that no one would consider the adoption of the new proposal, and its advocacy in the face of the results obtained appeals to the writer as being extremely ill-conceived.

The writer appreciates that when a large organization like the National Paving Brick Manufacturers Association agrees to manufacture a brick of this type and promote its use under the specifications, there will undoubtedly develop a demand for this material, particularly in those communities where facilities for study and experiment along these lines are not ample. He does not believe, however, that the larger cities with ample engineering staffs, or even the city engineers of the smaller communities, who have been able to devote any considerable time to this subject, will agree to these specifications, and is quite certain that the lugless brick and the sand cushion will continue to be considered as serious obstacles in the way of successful brick pavements. Aside from the purely technical aspects of the specifications the writer cannot help but question the propriety of the presentation of a reactionary specification of this type by the manufacturers at a time when the engineers generally are thinking more than ever along technical lines. The presentation seems to come not in response to any demand from the engineers, or the consumers, but purely on their own initiative, and as a phase of manufacturing detail.

The writer is even rather inclined to question the applicability of the reasons given for the change; for instance, even though twelve standards of paving brick may be excessive, is it necessary to go so far as to reduce to one? The increased percentage of No. 1 brick of a 3 x 4 in. size is not universal. In some localities the percentage of the No. 1 type of the 3-inch brick has already been found to be less than the block. While the matter seems to have arisen out of the internal conditions of the brick industry, there is a reasonable doubt whther the remedy is satisfactory, even from the manufacturing view point, to all the manufacturers.

CLYDE L. HUFF
City and Hydraulic Engineer, Logan, Iowa

I wish to say in this connection that I do not consider that as good a pavement can be constructed with lugless brick as with the lug brick, owing to the fact that it is practically impossible to get a positive joint between the brick by using the lugless brick. This, in my opinion, applies especially to the monolithic type of construction. I have heard some comment about this matter and it seems to me that the brick manufacturers are losing sight of the fact that paving brick are made for use in constructing brick pavement. Their contention is that they cannot sell their seconds and that as a result they must charge more for the lug brick than for the other. They do not back their statement with any proof as to whether they will make as good pavement, and it is the opinion of many engineers that lugless brick will not make as good pavement as the lug brick, which is the result we are all looking for.

The sand cushion, with a good even base and a thin layer of sand, makes a very good pavement.

Art and Science in Engineering

THE parts that art and science play in the various branches of engineering was briefly put by Arthur Surveyer in a discussion on engineering education before the recent annual meeting of the Engineering Institute of Canada. Mr. Surveyer, who, in addition to his consulting practice, is a member of the board of directors of the Ecole Polytechnique de Montreal, called attention to the fact also that the Ecole is the only engineering school in North America where tuition is given in French. He thus states the case of art and science in the various branches of engineering:

Engineers can be divided into two great classes, according to the relative importance of the part played by art and science in the exercise of their profession. The building engineers and administrators of certain classes of utilities constitute the first group. This class includes the architectural engineer, the structural engineer, the public-works engineer and the engineer builder or operator of canals, harbors, railways and tramways. These technicians apply, in their practice, some of the principles of science, but they also—and this probably to a greater extent—apply empirical rules based upon the experience of others and constituting the art of the preceding generations.

The second group is composed of the industrial or manufacturing engineers. Their field of action is very wide; it includes the fabrication of all engines and machinery, all the applications of chemistry, such as metallurgy, electrochemistry, electro-metallurgy and the series of industries dealing with the transformation of materials, such as dye works, pulp and paper manufactures, tanneries, sugar refineries, glass works, potteries, gas plants, etc. It also embraces all the applications of physics to the compressed-gas, cold and liquid-air industries and the ever-increasing number of applications of electricity to the construction of electrical machinery and wireless telegraphy. This group of engineers utilizes science to a greater extent than art, and their formation requires more laboratory work and less *ex cathedra* teaching.

Thermit Weld Used on Ore-Dock Tie Rods

Side walls of a concrete ore dock of the Algoma Steel Corporation, Ltd., at Sault Ste. Marie, Can., are of such a distance apart as to require tie rods 185 ft. long. Each of the 13 rods, of 3¼ in. square steel sections, had to be welded in three places in order to get this length, making a total of 39 welds required. Electric welds were tried at first but in tests gave a strength only about 27 per cent of the original bar. Accordingly thermit welds were resorted to, with resulting tests of over 85 per cent of the original bar. There was some difficulty in doing the work because the rod elevations were below high water, but by picking the proper time the 39 welds were made by seven men in nine days.

Ocean Pier to Be Scrapped Because of Concrete Disintegration

Concrete in Santa Monica, Cal., Structure Has Been Succumbing to Sea-Water Attack Since Erection Ten Years Ago

DISINTEGRATION of the concrete in the municipal pier at Santa Monica, Cal., has become so severe and extended that the structure was closed to public use in November, 1919, and steps are being taken to rebuild another pier. A board of consulting engineers has inspected the pier and investigated the design and the conditions surrounding its construction. It has reported that the failure is due to the gradual decomposing action of the sea water on a concrete which was not of the high standard now known to be required of concrete to be attacked by seawater.

The municipal pier at Santa Monica was built in 1908-09 to carry an outfall sewer and to serve for a pleasure pier. It was described in some detail in *Engineering News*, Dec. 9, 1909, p. 632. It is 1,600 ft. long and 35 ft. 8 in. wide at the deck line, with three platform spaces 89 ft. wide at intermediate points and at the end of the pier. The floor is concrete on timber stringers which span concrete floorbeams on concrete bents of posts cast in place on concrete piles sunk by jetting. The bents are spaced 20 ft. c. to c. and the piles are in three rows with 13 ft. 6 in. spacing. Deck elevation varies from 21 to 50 ft. above ocean bottom, but the piles were not braced together, either transversely or longitudinally, below the floorbeam level.

Piles were precast on shore and sunk into place by jetting. They were round and provided with a bulb bottom, shown in the drawing, and were cast at an angle of 40° to the vertical. Outside of those two features their construction and placing were normal. Details regarding them, as given in the article noted above, are as follows:

The structure is divided into three approximately equal sections. In section 1 [nearest the shore] the piles are 14-in. diameter, reinforced with six ¾-in. rods and have a jacketing of No. 10 steel 22-in. diameter extending from 2 ft. above high water to 2 ft. 6 in. below ground line; the space between the pile and the jacket is filled with concrete. In sections 2 and 3 the piles are 18 and 22-in. diameter, respectively, reinforced with eight ¾-in. rods in the 18-in. and eight ¾-in. rods in the 22-in. piles. It was the intention to protect the piles in sections 2 and 3 with a jacket of the same diameter as the piles, extending 3 ft. above and below the tidal range, but the prompt covering of the wet surfaces by marine mollusks rendered other protection unnecessary. All concrete was a 1:2:4 mixture with stone limited in size to 1 and 2 in. in piles and substructure, respectively.

The pier apparently suffered no deterioration for some years. In 1912 Rudolph J. Wig and Lewis R. Ferguson, in their tour of inspection of various seawater concrete structures in the United States, inspected the pier and found no trouble. In 1916, however, disintegration had started. A statement by Mr. Wig reads as follows:

An examination made in 1912, four years after the structure had been built, showed the pier to be in excellent condition. For about the first 200 ft. of the pier at the inshore end, the piles were carefully examined and they showed no cracking or indications of spalling or disintegration. The piles at the outshore end were only examined as they could be viewed from the pier deck and they appeared to be in excellnt condition. This pier as a whole was found to be in better condition than any similar structure on the Pacific Coast.

A later and more careful examination was made in 1916. The records show that, during the original construction of the pier in 1908, thirteen of the piles were broken by storm after being set in place and had to be removed. Prior to 1916, a number of piles had failed on the outboard end supposedly having been damaged by floating debris. These were repaired by using steel shells of 10- and 12-gage metal, the shells having a diameter of approximately 8 in. greater than the diameter of the old pile. In repairing these piles, it was found in a number of cases that the concrete of the damaged or broken pile was quite soft and more or less disintegrated. In fact, it was stated, it was so soft it could easily be cut away with a knife. The failure usually occurred above low water and the steel shells or jackets were only placed around the piles from a point near low water to a point above high water. No examination had been made by a diver of the condition of the outboard piles

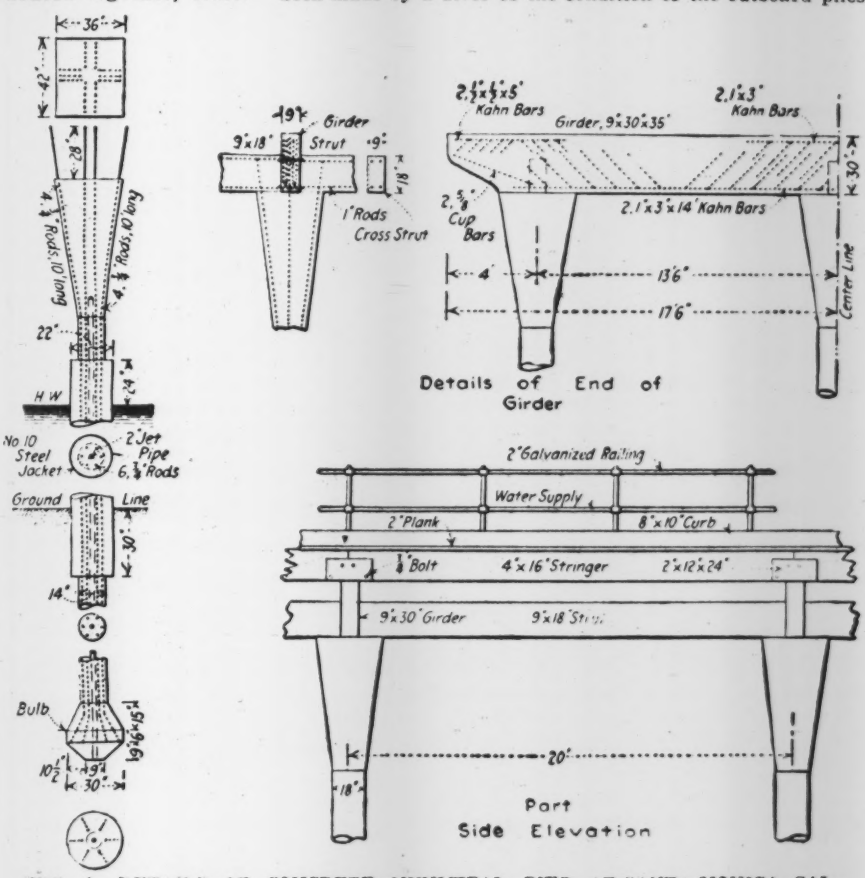


FIG. 1. DETAILS OF CONCRETE MUNICIPAL PIER AT SANTA MONICA, CAL.
(Reproduced from *Engineering News*, Dec. 9, 1909, p. 632.)

below low water. They were covered with a very heavy marine growth and therefore could not be readily examined.

An analysis of the disintegrated concrete was made in July, 1915, by R. G. Osborne of Los Angeles and it was found to have the following composition:

Silica	53.56
Iron and Alumina	11.88
CaO	8.28
MgO	2.88
$MgSO_4$	8.63

The high percentage of magnesia in this sample shows that disintegration of the cement had been going on for some time. Many of the piles at the inboard end which could be examined showed cracking and spalling.

The cracks for the most part were vertical and above the elevation of mean tide. They appeared to be located over the vertical reinforcement. Some of these piles were appreciably eroded. It is of special interest to know that no disintegration was apparent in 1914, after the structure had been exposed to seawater for four years, while during the subsequent four years deterioration was quite rapid. Some of the piles had the appearance of failing by compression at the point where they were badly cracked. The concrete beams which carry the deck were also cracked, many of them for the entire length, both top and bottom of the beam at points which appeared directly over the reinforcement.

It appears that for some of the piles beach sand was used which contained some particles of black shale. Such particles of shale which were embedded in the concrete within ¼ or ½ in. of the surface oxidized and caused spalling of small particles. This defect was not very extensive, however, although it may be a contributing factor. It was quite apparent that joints had been made in some of the concrete piles at a point such that when the pile was driven the joint was located at about the elevation of mean tide.

The trouble indicated in the foregoing report continued through the years 1917 to 1919 until last August, a settlement of the outboard end when the pier was crowded with people led the city commission to engage a board of engineers to report on the condition of the

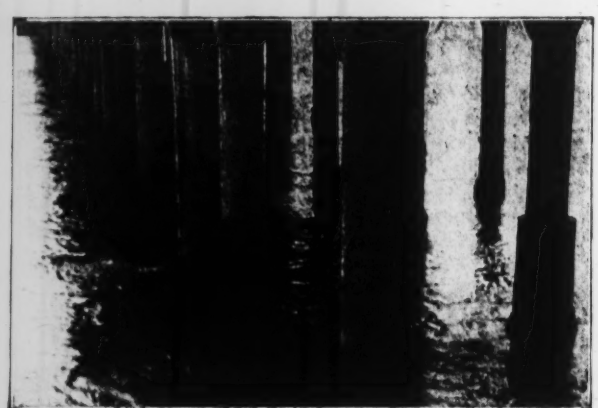


FIG. 2. UNBRACED CONCRETE PILES UNDER SANTA MONICA PIER

structure. The main part of this report dated Nov. 5, 1919, and signed by Quinton, Code V. Hill, represented by J. H. Quinton; Olmsted & Gillelen, represented by Frank H. Olmsted; and Leeds V. Barnard; represented by W. K. Barnard, is as follows:

In a detailed examination of every part of the concrete substructure the following conditions were discovered:

Of 42 bents containing originally a total of 150 piles examined by diver, the condition was found to be as follows:

Under low-water mark—3 piles were gone completely; 3 piles were practically gone; 60 piles were rusted so badly as to show that oxidation of the steel had set in; 30 piles were cracked showing that disruption was in an advanced condition; 54 piles were apparently still serviceable, as most of these were cased with iron and concrete.

Above low-water mark—3 piles were gone completely; 3 piles were practically gone or useless as bearing piles; 91 piles were cracked in two or more places; 33 piles showed one crack; 20 piles showed no visible sign of deterioration.

It was not considered necessary to spend any more money on examination of the piles under water, as the above enumerated defects show plainly to our satisfaction that the piles are so badly deteriorated that the pier as a whole should be condemned.

In addition to the above 42 bents which were examined under water by diver, and above water by ourselves personally by means of boats, the following 16 bents, at the shore end, containing 48 piles, have been examined by us at time of low water and the following defects noted:

Forty-six piles were cracked in two or more places; 1 pile showed one crack; 1 pile showed no visible sign of deterioration.

As the entire structure rests on piles alone, the failure of the piles means the failure of the pier. Considered as a whole, the pier is in a very dangerous condition, and any great winter storm is liable to wreck it wholly or in part. On no account should the public be allowed to use it further, as many parts of it are liable to fail at any moment.

Cause of Present Condition

The underlying cause of the present condition of the pier was, in our opinion, porous and permeable concrete. Because of this permeability, the salt water has penetrated the concrete, producing two results; the chemical disintegration of the concrete itself and the mechanical fracture of the same as a consequence of the expansion of the reinforcing steel due to its corrosion. The final result of this disintegration and fracture of the concrete is, of course, such a destruction of the strength of the piles and other parts of the structure as to render them unable to bear their proper loads.

Our examination revealed that while the chemical disintegration of the concrete itself took place, in general, under water, or between high and low tide, the cracking of the concrete along the lines of reinforcement took place almost entirely in the caps and struts and above high water in the piles. The cracking, as though the result of a wedge-like action at the reinforcing rods, is so general throughout the structure above water that it points to general corrosion of the metal due to one or both of two causes—permeable concrete, as indicated above, or electrolysis.

The appearance of some of the piles would indicate the electrolysis may have taken place in the earlier life of the pier. A careful examination during October, 1919, with a millivoltmeter showed that there was a very slight difference of potential between the sewer discharge line on the pier and the reinforcing steel in the piles. This difference fluctuated synchronously with the stopping and starting of cars on the Pacific Electric tracks nearby. No electric current which would cause electrolysis, however, could be detected in the sewer discharge line. Whether the electrical machinery in the pumping and treatment plant at the shore end of the pier was running or not, the results were the same, irrespective of movement of street cars. Any electrolysis, if it did occur, has now almost, if not entirely, ceased, and probably for two reasons—first, the adoption of improved bonding methods by the electric railway, since the pier was built, to prevent electrolysis, and second, the corrosion of the steel increasing to such an extent as to form an insulation of oxidized metal about the reinforcement. Although the nature and the degree of the corrosion, and the even yet detectable difference of potential, might furnish slight reason for thinking that electrolysis had something to do with the initial fracture of the concrete, we are of the opinion that the most potent cause of the corrosion was the porous, permeable concrete which allowed the salt sea air to penetrate to the steel.

An examination of many examples of concrete work from

Santa Monica to Redondo shows that in many instances the same destructive action is taking place where there is no reason to expect to find electrolysis and where the concrete is not directly in contact with salt water. Many porous concrete works such as lamp posts and railings are found to be failing solely as the result of their exposure to salt sea air. Dry mixed concrete, such as is commonly used in such "artificial stone" lamp posts and railings, is quite as porous and permeable as concrete mixed too wet.

It is clear from the above that the cause of the present condition of the pier was permeable concrete. This permeability can result from several causes, any or all of which may arise in the absence of the most rigid and competent inspection and careful and conscientious workmanship, or from improper design.

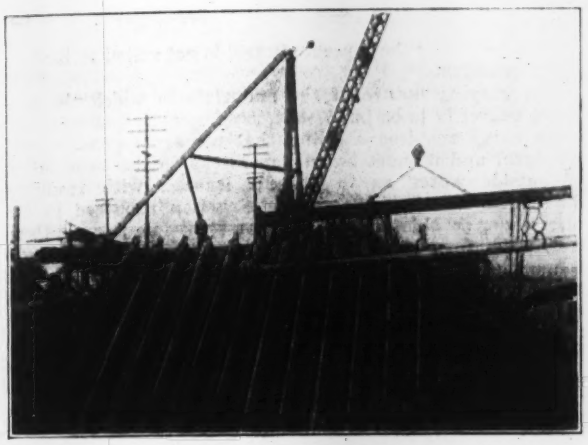


FIG. 3. CASTING THE SANTA MONICA PILES IN 1908

In the light of the present-day knowledge, permeable concrete may result from the use either of too much or too little water. Numerous experiments have demonstrated this. The concrete may be so placed in the forms that there is a separation of materials and consequent alternating dense structure and rock pockets with a large percentage of voids. Forms may be so poorly designed as to be leaky and so allow the loss of the cement, leaving an unfilled mass of aggregate. Reinforcing steel may be placed too close to the surface to permit of its being adequately covered even with the most dense concrete obtainable. Forms may be removed so awkwardly and piles may be handled so roughly that the "skin" of lime carbonate is broken and so access is given to the interior concrete for the salt water.

Many if not all of these facts have become known as the result of the experience and experiments of the last few years and were not available to the designers of marine concrete construction a decade ago.

In the light of our present information it is realized that the reinforcement should have been more deeply imbedded, but at the time the pier was designed any engineer would have said it was quite sufficiently covered.

The diary of the inspector records that beach sand and gravel were used in the concrete. This we believe to be an unsafe practice in reinforced-concrete construction, for the salt contained therein facilitates the corrosion of the metal reinforcement. Moreover, because of the sorting process of nature in the formation and deposit of beach sand, a very uniform, ungraded product results, which requires the use of an excessive amount of cement to prevent getting a very lean, porous mixture. Clean sand and gravel or crushed rock should be used and so graded that, with the cement and a proper amount of water the least volume of concrete will be produced with a given quantity of ingredients. This will produce a dense impermeable concrete.

It should be needless to say that any skimping of the cement required for a properly proportioned mixture would result in a poor and permeable concrete.

From the inspector's diary, it appears that, at least at first and perhaps throughout the course of the construction, some difficulty was experienced in getting satisfactory materials and tight forms and that the workmanship and manner of handling of the piles left something to be desired.

The chemical analyses established very conclusively the fact that the disintegrated concrete lost 23 per cent more lime than the good concrete and gained over 9.5 per cent of magnesia, in the form of magnesium hydroxide. The absorption test on pieces of concrete taken from the pier where chemical disintegration had not taken place, but where piles had been fractured by the corrosion of the metal reinforcement, showed an absorption of water by weight of from 6 per cent to 7 per cent of the original weight of the specimen. A single test made on a more porous piece of concrete showed an absorption of 12% by weight.

We have tested some pieces of the concrete taken from the pier in some places where failure had occurred, and found that the concrete absorbed water to the extent of between 20 and 25 per cent of its volume. This absorption is about the same as that of common brick. Such concrete could not be said to be dense, and unless perfectly protected by an impermeable coating of rich mortar, would naturally allow sufficient absorption of seawater to reach the steel.

Conclusions

In consideration of all of the above facts and observations we believe we are fully justified in concluding that the prime cause of the failure of the pier was the permeable concrete resulting from unskilled or poor workmanship and improper selection and use of materials. A possible contributing cause was the occurrence of two quite severe storms during construction, which cracked many members of the structure, rendering them still more liable to attack by the salt water and air. Electrolysis may have accelerated the corrosion of the reinforcement in the earlier days, but we do not find evidence of its present operation.

It must be born in mind that much of our knowledge of the way to make concrete which will resist the action of seawater has been gained since this pier was built, and it is far from our intention to cast reflections on any one in connection with its construction, for we believe that it was well designed and constructed under considerable difficulties. Our only finding is that the materials of the concrete appear to have been not well selected, and not combined in the proper portion with proper amount of water to make a sufficiently dense concrete to prevent the seawater from reaching the imbedded steel.

In consideration of the above facts and having in mind the difficulties attending the making of a structure impervious to moisture, particularly in replacing the present piles and other concrete substructure without removing the deck, we are of the opinion that it is inadvisable for the City of Santa Monica to attempt to reconstruct the Municipal Pier in reinforced concrete.

Regarding the claim that more might have been done to keep the pier in proper condition we have to say that in our opinion every reasonable effort has been made to maintain the pier in a safe and usable condition and that nothing could have been done at any time since the structure was built to have prevented its present conditions or appreciably prolonged its life.

Claims that the building of the wooden structure to the south of the pier had anything to do with the present condition of the pier are, in our opinion, without foundation.

In conclusion we would recommend that the further use of the Municipal Pier be prohibited and that steps be immediately taken looking to the replacement of the present concrete piles, caps and struts by creosoted wood piles and timber caps and struts, retaining the present deck structure. Such a substructure should have a life approximately equal to the remaining life of the existing deck structure, and so the greatest possible use of the original investment consistent with public safety will be made.

As a result of this report the City Commission ordered the discontinuance of the Municipal Pier by the public. A new creosoted pile pier will be built.

Controversy Over Concrete-Block Tunnel Construction

SHARPLY divergent views on subaqueous tunneling practice were brought out during the past few weeks in the course of public hearings on the Hudson River vehicle tunnel project, intended to provide a highway connection between New York City and Jersey City as a joint state enterprise of New Jersey and New York. There has been keen interest in these hearings among engineers generally, most largely in the controversy between the advocates of cast-iron and concrete tunnel shell construction. Several documents bearing on this controversy, which were made public at the hearings, are reproduced in condensed form herewith.

After the chief engineer of the joint commissions, C. M. Holland, had reported upon the preliminary engineering studies and recommended a plan and design, as abstracted in *Engineering News-Record* of Feb. 19, 1920, p. 357, a series of public hearings was arranged, to collect opinions on questions of traffic capacity and on type of structure. As reported in our news columns, much of the discussion at these hearings centered around the 42-ft. tunnel to be built of precast concrete blocks laid up behind a shield, and to contain two levels each with a 22½-ft. roadway (intended for three lines of traffic), recommended three years ago by Gen. George W. Goethals, then consulting engineer to the commissions. The present chief engineer and board of consulting engineers rejected this recommendation and condemned the proposed tunnel, in spite of the claims of low cost made for it. The pair of 29-ft. cast-iron tunnels recommended by the chief engineer, providing two 20-ft. roadways each to carry two lines of vehicles, would cost $22,262,000 net (or $28,669,000 with real estate, engineering, contingencies and equipment), as against estimates of twelve to fifteen millions claimed for the single large concrete-block tunnel. The chief engineer reports that these latter figures are far too low.

Mr. Holland and Col. W. J. Wilgus of the consulting board presented statements at the public hearings, giving the reasons for condemning the concrete-block tunnel on the score of safety and practicability. Parts of these statements are reproduced below.

Statement of Chief Engineer Holland

Five questions were addressed to the tunnel commissions by General Goethals recently asking for the technical basis for the rejection of the concrete-block tunnel plan. A reply to these questions was prepared by the chief engineer, under date of Feb. 28, 1920, with the full endorsement of the consulting board. The substance of this reply follows:

Item 1.—"The data showing how the conclusion is arrived at that the capacity of the tunnel is greatly overestimated."

The tunnel in question is shown with a roadway width of 22 ft. 6 in., which it is claimed will carry three lines of vehicles. A study of motor truck growth shows the absolute necessity of providing for a great volume of trucks 8 ft. in width and for touring cars 6 ft. in width, making the combined width of two trucks and one touring car 22 ft. This leaves a total of 6 in. for all operating clearances, from which it is manifest that such a roadway cannot carry three lines of traffic. Therefore any estimate of more than two lines of traffic is an over-estimate.

Item 2.—"The analysis which shows that the rings or blocks are not sufficient to withstand the external load."

I transmit herewith the analysis [not reproduced—Editor] which has been prepared on the basis of the presence of ideal conditions which are never met with in practice in tunnel construction. They are merely supplemental to the studies based upon actual tunnel experience which show that the concrete-block tunnel is fundamentally defective in that it does not provide for strength in those details where tunnel experience has proved that strength must be provided; especially, in the cross-joints where it has been found necessary to increase the rigidity of the connections between adjacent segments in order to strengthen the ring and prevent its failure through distortion.

Item 3.—"Why the concrete tunnel is not suited to Hudson River conditions."

The varying nature of the materials in which the proposed tunnel is to be built (silt, sand, gravel, boulders, and ledge rock) requires a lining that possesses great lateral strength, and it must be so impervious to the penetration of outside water as to prevent leakage with resulting disintegration. The type of construction proposed in the plan under consideration is the worst possible to meet these conditions, formed as it is of concrete blocks without rigid connection at the cross-joints, which experience through thirty years of subaqueous tunnel construction has shown to be an absolute prerequisite of successful construction under the conditions found under the Hudson River. The introduction of tens of thousands of joints between abutting concrete surfaces without rigid connection makes the matter of obtaining a water-tight tunnel an absolute impossibility. The result would be that if such a tunnel could conceivably be built, it would present from its very nature an untold number of points of attack by the natural forces of disintegration which would seriously endanger its permanency.

Item 4.—"The data on which the statement is made that the estimates are too low."

1. The concrete blocks are estimated at $11 per cu.yd. in place. At the current price the cost of materials forming the blocks would be $9.32; this leaves a balance of $1.68 to cover the following items of expense: providing a plant, transporting raw materials to the plant, fabrication of the blocks, transporting blocks from plant to the storage yards for seasoning, storage, transportations of the seasoned blocks from the storage yard to the tunnel shafts and into the tunnel heading through compressed air, erection of the blocks behind the shield, breakage during fabrication, transportation and erection, making these blocks water-tight, and finishing. The cost of these blocks figured on present-day prices for labor and materials shows that they cannot be fabricated and erected for less than $33 per cu.yd., which is three times the cost set forth in the estimate. In this connection it might be mentioned that the estimate in question fixes the price for concrete in the tunnel approaches under normal atmospheric pressure, a much cheaper form of construction, at $20 per cu.yd., which figure more nearly corresponds to present-day costs for that type of less expensive work.

Another element of the unit prices as considered in the estimate is the cost of excavation, which is classified under two items: tunnel excavation in silt, 342,500 cu.yd., at $8, amounting to $2,740,000, and tunnel excavation in rock, 45,000 cu.yd., at $22, amounting to $990,000, a total allowance for the cost of tunnel excavation of $3,730,000. In the first place the classification of the materials is incorrect, for the borings demonstrated that the materials through which the tunnel must pass are mud, silt, sand, gravel, boulders and ledge rock, which should be properly classified as tunnel excavation in silt, tunnel excavation wholly in earth other than silt, and tunnel excavation in part earth and part rock. Assuming that the tunnel were to be built in accordance with the permit of the Secretary of War, with a protective blanket 10 ft. in thickness, which experience has shown is necessary for the safe construction, maintenance and operation of a subaqueous tunnel, the quantities for excavation under the above conditions should be: exca-

vation in silt, 177,500 cu.yd.; excavation in sand, gravel and boulders (wholly in earth), 100,800 cu.yd., and excavation in part earth and part rock, 70,500 cu.yd. A fair average estimated price for the excavation of materials under the above classification is $27.72 per cu.yd., making a total cost of the above estimated quantities for tunnel excavation $9,700,000, which again is approximately three times the total as estimated for tunnel excavation for the concrete block tunnel.

2. The estimated quantities are insufficient in that such items as waterproofing, tunnel ducts and the reconstruction of sewers, water and gas pipes and other subsurface structures are entirely omitted from the estimate, while the quantities of such items as steel and pavement are too low.

3. The allowance for plant in the estimate under consideration is $1,435,000, which is based upon the use of only one shield, an expensive and slow method of construction. The plant estimate is absolutely inadequate for the purposes intended, and the cost of the plant required for the economical prosecution of the work in question would amount to $2,658,000.

4. No amount is given in the estimate for the necessary real estate. This is a serious omission as in any event it cannot be less than the amount submitted to the commissions in the chief engineer's report, namely $2,500,000, which should be added to any estimate made for this work.

Item 5.—"The data in support of the statement that the tunnel cannot be built within a period of three years."

The concrete block tunnel 42 ft. in diameter is without precedent and no tunnel approaching its size has ever been driven under the Hudson River or any other river. The progress which could be maintained during the construction of this tunnel is a matter of conjecture. The one thing certain is that the larger the tunnel, the greater will be the uncertainties and difficulties of construction, and the slower will be the progress. In the estimated cost of $12,000,000, submitted to the commissions, provision is made for only one shield. In order to build this tunnel in a period of three years, it would require an average daily progress of more than double that attained in driving the Pennsylvania tunnels under the Hudson and East rivers or the recent rapid-transit tunnels under the East River—an impossible supposition.

Summary.—As designed, the tunnel would float if it could be built as shown upon the plan.

As designed, the tunnel would be placed with its top even with the government improvement plane and would therefore be without any protective covering and consequently unsafe.

With the unprecedented diameter proposed for the tunnel in question, if built as shown, the vehicular capacity would be that of two lines of traffic or the same as that of the cast-iron twin tunnel approved by the commissions.

The proposal to build a tunnel of unprecedented diameter, of untried materials, abandons all that experience in tunnel building has taught in the gradual development to the present state of knowledge and enters upon a new field of uncertainty.

It is useless to discuss seriously the details of the cost of a structure that experience shows cannot be built, but the errors shown in the estimate of cost of the proposed structure point to no possible economy in the kind of construction proposed.

C. M. HOLLAND, Chief Engineer.

STRENGTH OF CONCRETE BLOCK TUNNEL PROJECT REVIEWED BY W. J. WILGUS

Subsequent to the reply to Chief Engineer Holland, a further statement on the subject was presented for the Board of Consulting Engineers by William J. Wilgus, chairman, at a public hearing on the tunnel held in Newark, March 4, 1920. Of this statement, portions, criticize the location of the New York approach of the Goethals tunnel, the inadequacy of roadway width provided (22½ ft.) if three lines of traffic are to be carried, the high cost of ventilation on account of providing only two shafts between portals, the insufficiency of the estimated cost, and the operating costs. It deals with the subject of tunnel design substantially as follows:

Nature of Material:

Views have been expressed by the patentee of the precast concrete lining and differential pressure shield, to the effect that the material through which the tunnel is to pass is stiff clay of sufficient hardness to prevent the distortion of the tunnel, provided the annular space between the exterior of the tunnel and the surrounding material is filled with a gravel-grout as the shield progresses.

Apart from the opinion of members of the Board of Consulting Engineers, whose experience with this material leads them to disagree with the patentee, there are high authorities who have placed on record their observations which are contrary to those expressed by him.

At the Detroit River Tunnel, in the general region where the patentee states that he has recently constructed a tunnel lined with his blocks, the stiff blue clay weights 135 lb. per cu.ft. and carries from 15 to 18 per cent of moisture. Ordinary soft clays which would be more plastic and hence less firm than the material claimed by the patentee to underlie the North River, will average 120 lb. per cu.ft. Prof. G. H. Cook in 1874 determined the specific gravity of a large series of clays from New Jersey and gave their maximum weight as 135 lb. per cu.ft., their average weight 114 lb. and their minimum weight 96 lb.

What do we find from actual experience are the characteristics of the material through which it is proposed the tunnel shall be built? In the report made by General Raymond on the North River tunnels of the Pennsylvania R.R., many references to this subject by himself and his associates are to the effect that this material is "fluid silt" weighing from 78 to 80 lb. per cu.ft. at the bottom of the river and increasing to about 100 lb. at the depth of 40 ft.; also, that experiments show that this silt, weighing up to 98 lb. per cut.ft., causes objects lighter than it to rise immediately, though very slowly. Other observations reported by him were to the effect that the weights of the material surrounding the Pennsylvania R.R. North River tunnels would average 108 lb. per cu.ft. Mr. Charles M. Jacobs describes the material through which the Hudson River tunnels of the Hudson & Manhattan R.R., were built as a silt containing about 30 per cent water, weighing 103 lb. per cu.ft. and being in its natural state "very soft." Those interested in checking up the statements of the patentee and of General Goethals as to the nature of material encountered at the original Hudson River tunnel, should read the account thereof in Drinker's authoritative work on "Tunneling," pp. 961 *et seq.*

It will thus be seen that engineers of the highest reputation, who had charge of the building of the existing tunnels beneath the North River, describe the material in question, not as a hard or firm clay having high specific gravity and a comparatively small percentage of moisture, but as a silt having a specific gravity and a percentage of moisture that class it among the softest clays of the region.

Hence, it is evident that unbalanced pressures are to be anticipated through the river silt. Even in a greater degree unequal loads are to be anticipated inshore from the bulkhead lines where the material is less homogeneous.

Stresses:

As the material through which the tunnel is to pass is shown to be of an unstable nature, and unequal pressures therefore are to be encountered, the design must be such that the tunnel will safely resist such stresses without sufficient deformation to cause the joints of the blocks to open. With a 1 on 5 (11 deg. 19 min.) slope of the surrounding material, basing the forces on Rankine's theory of earth pressures, ignoring any reactive pressures and assuming that the concrete ring is a true elastic circle (an assumption which is more favorable than conceivably would be true), it is found that the tunnel stresses are as follows: Maximum compression in the ring 1,000 lb. per sq.in.; maximum tension in the ring 400 lb. per sq.in.; shear in the lugs, assuming uniform distribution of the load, 1,192 lb. per sq.in. As permissible stresses in concrete, under the build-

ing code of New York, are 500 lb. in compression, zero in tension and 40 lb. in shear, it is apparent that the stresses found to be present in this design are grossly excessive.

It should be realized that the perfect fit of the blocks assumed in making these calculations is not obtainable in practice, and that unescapable irregularities and the non-elastic deformation of the circle due to the unbalanced pressures would bring even greater stresses into play. However, the stresses shown are far in excess of those permitted in approved practice and in fact are such that the tunnel, if constructed, would collapse.

Durability of Structure:

Experience has shown that concrete structures suffer disintegration when exposed to the infiltration of acid-bearing waters. The underground waters on the New Jersey side of the North River are known to be thus affected and it is possible, if not probable, that the vehicular tunnel will be exposed to this destructive agency, which a concrete block structure with its thousands of vulnerable joints would be peculiarly unadapted to resist.

Proposed Type of Shield:

With the 42-ft. diameter tunnel it is proposed to use a shield having four horizontal compartments carrying differential air pressures, on the theory that by setting the face of each compartment 3 ft. back of the one below, the higher air pressure in the latter will pass vertically through the ground without a backward movement against the face above. This theory ignores the presence of cracks in the material which follow each shove of the shield; also the presence of obstructions such as piles, large boulders, sunken vessels, etc., which offer channels for the air from the lower faces to the upper ones in such manner as to equalize the air pressure on the entire face. In practice, therefore, this device would become an ordinary single-pressure shield in which the air pressure necessary to exclude the entry of water at the bottom of the shield would be greatly in excess of that required at the top, with resultant blowouts. Moreover, the differential-pressure shield has serious disadvantages, such as the need of successive sawing off of piles and other obstructions as the shield advances, because of the projection of the lower stages of the shield beyond the upper ones. Also, experience has shown that shields rotate, which means that the floors of the compartments instead of remaining horizontal, would gradually tip in such manner as to become unworkable and also bring about the equalizing of the air pressures which this design is proposed to obviate. There are other practical objections to this type of shield, the most important of which are the danger to the men in the working chambers in case of an inrush of water and the practical certainty that many blocks, with their unavoidable slight irregularities, would be broken under the enormous jack pressures.

O'Rourke on Tunnel Costs

To bring out the cost comparison of concrete-block and cast-iron lining directly, J. F. O'Rourke presented at the hearing of March 4, 1920, estimates for a pair of 31-ft. tunnels with 33-in. concrete-block lining, and corresponding estimates for the pair of 29-ft. cast-iron tunnels of the official plan. These estimates follow.

In both, the tunnels are assumed each to be 9,000 ft. long of full cross-section, thereby allowing for the cost of approaches. Different types of ventilating shaft are estimated in the two cases, a steel caisson of full shaft size for the cast-iron tunnels, and an open shaft surrounded by a concrete caisson cofferdam for the concrete-block tunnels. The price of the former is computed in 1915 (pre-war) basis from the unit-prices paid for the steel caissons of the 14th St. rapid-transit tunnel, in New York ($49.30 and $51.40 per cu.yd. gross). The open-shafts are estimated as: 12,000 cu. yd. concrete caissons at $30; 2,000 cu. yd. walls and floors at $25, and 20,000 cu.yd. general excavation at $2; a total of $450,000 for two shafts.

Chief Engineer's Twin Cast-Iron Tunnels

Areas:	Sq.ft.		
30 ft. dia.	706.86		
29 ft. dia.	660.52		
25 ft. 6 in. dia.	510.70	}	concrete
28 ft. 2 in. dia.	623.10	}	
Quantities per Lineal Foot:			
26.2 cu.yd. excavation.			
Cast-iron lining, 8 tons.			
4.16 cu.yd. concrete.			
Cost per Lineal Foot:			
26.2 cu.yd. excavation	@$10.00		$262.00
4.16 cu.yd. lining concrete	15.25		63.44
2½ cu.yd. interior concrete	15.25		38.12
8 tons cast-iron lining	73.25		586.00
640 lb. bolts	0.10		64.00
500 lb. steel beams	0.05		25.00
Sundries			50.00
			$1,098.56
General Items:			
Power houses			$800,000
Power			400,000
60,000 cu.yd. shafts @$50			3,000,000
8 ventilating plants			400,000
8 shields			800,000
			$5,400,000
Cost of Tunnel:			
1,100 x 18,000		=	$19,800,000
			$25,200,000
20 per cent			5,040,000
Total estimated cost			$30,240,000
Chief Engineer's estimate			22,262,000
Difference of estimates for cast-iron tunnels			$7,978,000

Twin Tunnels With Concrete Blocks

Areas:	Sq.ft.		
32 ft. dia.	804.25		
25 ft. 6 in. dia.	510.71	}	concrete
31 ft. dia.	754.77	}	
Quantities per Lineal Foot:			
29.80 cu.yd. excavation.			
9.04 cu.yd. concrete lining.			
Cost per Lineal Foot:			
29.8 cu.yd. excavation	@$10.00		$298.00
9.04 cu.yd. concrete lining	15.00		135.60
2½ cu.yd interior concrete	15.25		38.12
560 lb. steel rods and washers	0.10		56.00
500 lb. steel beams	0.05		25.00
Sundries			50.00
			$602.72
General Items:			
Power houses			$800,000
Power			350,000
2 shafts			450,000
2 ventilating plants			150,000
4 shields			400,000
			$2,150,000
Cost of Tunnel:			
600 x 18,000		=	$10,800,000
			$12,950,000
20 per cent			2,590,000
Estimated total cost with concrete blocks			$15,540,000
Estimated total cost with cast-iron lining			30,240,000
Estimated saving with concrete blocks			$14,700,000

Planning and Progress on a Big Construction Job—II

How Charts Kept During the Building of the Philadelphia Army Base Showed Performance in Various Details of the Engineering Work

By Charles Penrose
Progress Engineer Day & Zimmermann, Inc., Engineers, Philadelphia, Pa.

In THE preceding section of this article were described the Materials Charts, the Labor Charts and a reference made to the Administrative Charts which were developed by the Progress Department, so called, at the Army Supply Base at Philadelphia, and some explanation was given of the mechanism by means of which the progress work was carried on. In this succeeding part of the article will be described the Charts of Work Progress and Engineering Data, and some explanation given of the planning of the work, from week to week, during the process of construction.

Reporting of Physical Progress

The reporting of physical progress in the field at the Philadelphia port terminal development was obviously the backbone of the Progress Department's work, and it was made to embrace all of the major constructional operations, such as dredging, pile-driving and wharf work, concreting, bricklaying and other building construction, power-plant erection, etc.

As a first step, the Government reservation was divided off into zones. A *progress plan for each zone* was drawn up, and these were reported from postings made each week directly in the field. Such a plan, for the zone in which are located the large piers and warehouses at the Base (Fig. 8), exhibited the physical progress in that zone to the date of report, in terms of a legend of progress symbols also given. By using colors, progress made during the week immediately preceding the date of report was distinguished from progress made previously. It was found convenient also to indicate the location of all temporary buildings, and these were numbered and tabulated in a roster on the respective zone plan.

Complementary to the *progress plan* were the *longitudinal sections of the warehouse buildings*, reported weekly also in color. Similarly, these were brought up to date by postings made directly in the field.

In the other zones of the Government reservation, the same general method of reporting was employed; namely, by *progress plans*. However, these, while they gave complete general information to the date of report, and in a sense gave a "bird's-eye view" of the work, did not and were not intended to give analyses of the component operations, nor could they indicate the rate of progress.

Analyses of construction progress, the work schedules, and where and how the various parts of the project either were going ahead of or falling behind the Government program, were given in the *graphical charts*. These graphical charts, to be later described, included the major operations of dredging, pile-driving, etc.

For a basis for the graphical curves, as well as a means to keep in immediate touch with all work, comprehensive *daily reports were compiled in statistical form*, adapted to analysis. The form of report for daily performance of piledrivers is reproduced in Fig. 9, that for dredges in Fig. 11, and that for concrete mixing plants in Fig. 14. All are reproductions of actual reports, and in each case the date is indicated.

In all of these operations, the various crews engaged in the same kind of work were pitted against one another in good-natured competition, and the daily performances, best records and averages, as given in the reports were publicly posted by the Constructing Quartermaster every 24 hours.

Referring to the piledriver form in Fig. 9, the report is observed to have been made up in terms both of number of piles driven per crew and equivalent linear feet of piling measured below the point of "cut-off" of the pile. What had been driven previous to date of report, what was driven that day, and the total to date and the number of days at work, were shown *by crews;* as well as each crew's best previous day's record, and particularly the daily average performance of each to date. It was an easy matter to classify these statistics according to type of piledriver, whether land drivers, water drivers (floating machines), batter or spur piledrivers and land traveling rigs. This was done in the summary which appears in lower portion of the report, and gave opportunity for better comparison of the results of the day's work with past performances.

In all three of the forms reproduced here the emphasis is apparent as laid on *daily average performance* of piledriver crews, or of dredges, or of concrete-mixer plants, rather than especial importance being attached to sporadic day's "records." Averages rather than record performances tell the true story.

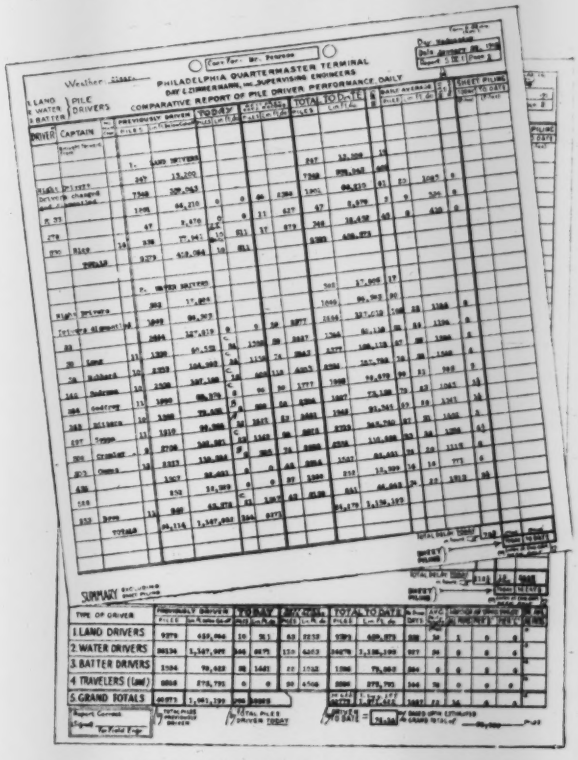


FIG. 9. REPORT FORM FOR DAILY PILEDRIVER PERFORMANCE

FIG. 8. WEEKLY PROGRESS PLAN FOR ZONE "A" AT PHILADELPHIA ARMY BASE

Showing status of construction at close of Government week ended May 27, 1919. Progress shown graphically by symbols given in legends. Colored portions (indicated in this reproduction by heavy cross-hatch on black background) denoted progress during the week immediately preceding the date of report, as distinguished from progress made previously. By use of "overlay" blue-printed sheets as shown, progress was indicated on each of the three floor elevations of the two Pier "B" warehouse structures. For example: In warehouse No. 1 the third-floor plan indicates that the section of floor slab (shown black) from river-end of structure to Column Bent 72 had been previously completed and that the slab (cross-hatch) between Bents 72 and 59 was poured *this week*. Other stages in warehouse construction and elsewhere in this zone, can be interpreted. The chart also indicates how the reinforced-concrete work was commenced at the river-end of each structure, and proceeded *inshore*. The above reproduction is about *one-seventh* the size of the original blueprint.

In the daily report for dredges (Fig. 11), made up in terms of yardage and dredge-hours, particular attention was given to the important feature of idle time of equipment, analyzed as to causes and whether the Government's liability or the contractors' liability.

On the other hand, in the daily report for concrete-mixing plants (Fig. 14), the classification of work done was according to location of pour and part of structure, because this allowed the percentage completion of the several structures to be shown on the basis of yardage. In the report the designations "F-1," "F-2," etc., found in column headed "Mach. No.," denote the *floating* concrete-mixer plants employed on this project. These consisted of material bins, mixer plants and gravity distributing towers all erected on floating barges.

As mentioned already, the statistical daily reports just referred to formed the basis for the *graphical charts of work progress*, and four of them will be described: those of pile driving, dredging, concrete work, and utilities progress.

The graphical chart of pile driving is shown in Fig. 10. A glance will admit that here little tracing cloth has been left blank—to go to waste. However, all of the data have a significance and these particular curves were among the closest watched.

For the reader that cares to go into further details, the chart will show a considerable number of features affecting the every-day performance of the driving of wooden piles, as well as over-all factors which, at the Greenwich Point project, largely governed progress and economy.

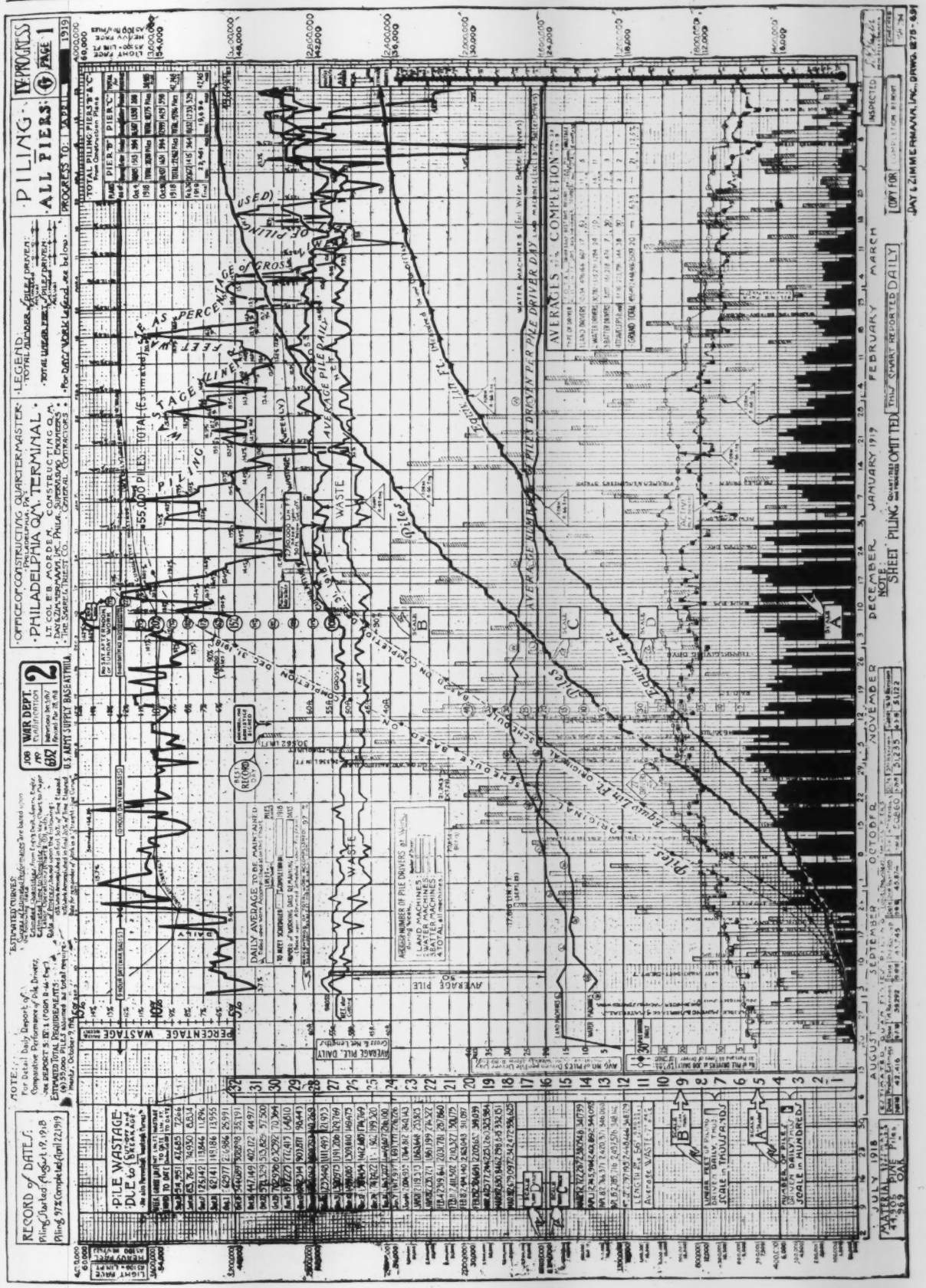


FIG. 10. GRAPHICAL REPRESENTATION OF PILE-DRIVING PERFORMANCE ON PHILADELPHIA ARMY BASE.

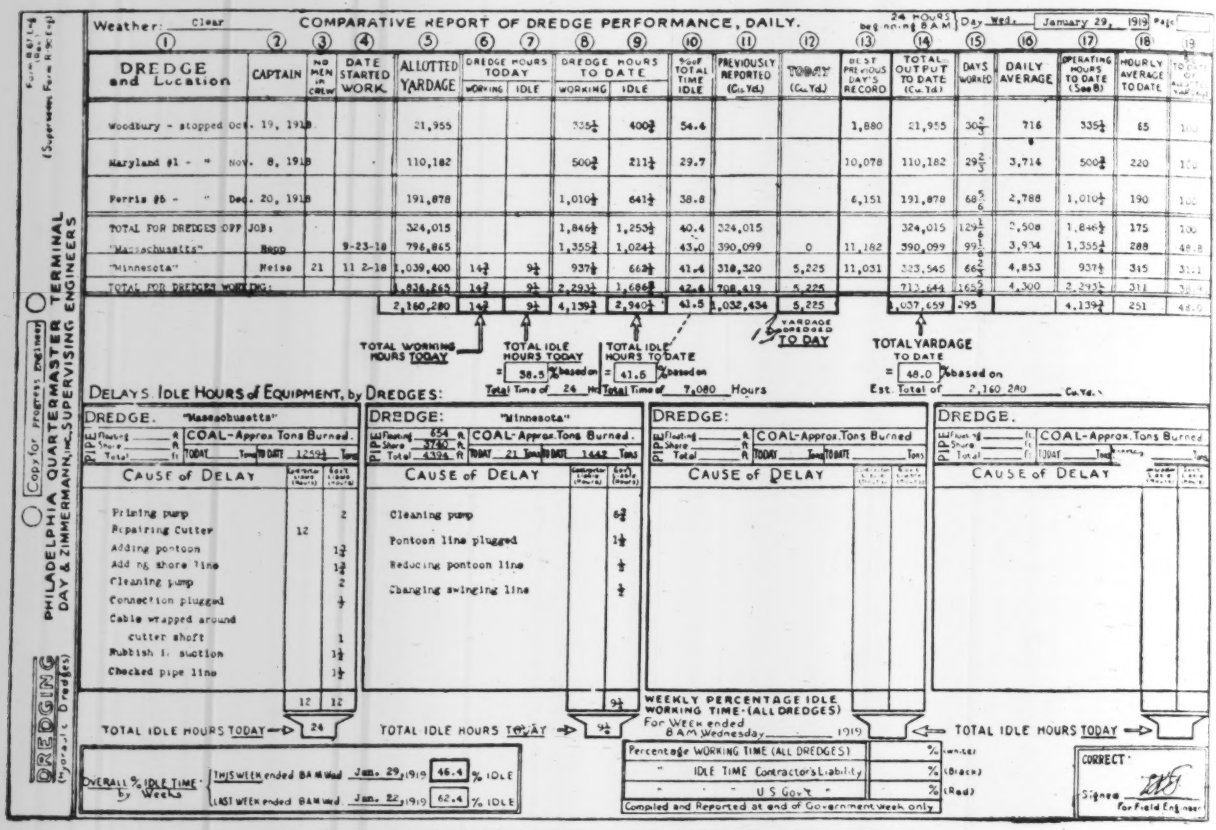

DREDGING (Hydraulic Dredges)
PHILADELPHIA QUARTERMASTER TERMINAL
DAY & ZIMMERMANN, INC. SUPERVISING ENGINEERS
Copy for progress Engineer
Form 8-Q-1-4 (Supersedes Form 8-Q-1-3)
Weather: Clear
COMPARATIVE REPORT OF DREDGE PERFORMANCE, DAILY.
24 hours beginning 8 A.M. Day Wed. January 29, 1919
DREDGE and Location
CAPTAIN
NO MEN in CREW
DATE STARTED WORK
ALLOTTED YARDAGE
DREDGE HOURS TODAY
DREDGE HOURS TO DATE
Total TIME IDLE
PREVIOUSLY REPORTED (Cu.Yd.)
TODAY (Cu.Yd.)
BEST PREVIOUS DAY'S RECORD
TOTAL OUTPUT TO DATE (Cu.Yd.)
DAYS WORKED
DAILY AVERAGE
OPERATING HOURS TO DATE (See 8)
HOURLY AVERAGE TO DATE
Woodbury - stopped Oct. 19, 1918
Maryland #1 - " Nov. 8, 1918
Ferris #6 - " Dec. 20, 1918
TOTAL FOR DREDGES OFF JOB:
"Massachusetts" Repp 9-23-18 796,865
"Minnesota" Weise 21 11 2-18 1,039,400
TOTAL FOR DREDGES WORKING:
TOTAL WORKING HOURS TODAY
TOTAL IDLE HOURS TODAY
TOTAL IDLE HOURS TO DATE
YARDAGE DREDGED TO DAY
TOTAL YARDAGE TO DATE
DELAYS IDLE HOURS of EQUIPMENT, by DREDGES:
DREDGE. "Massachusetts"
DREDGE: "Minnesota"
DREDGE:
DREDGE.
COAL-Approx. Tons Burned
CAUSE of DELAY
Priming pump
Repairing Cutter
Adding pontoon
Add'g shore line
Cleaning pump
Connection plugged
Cable wrapped around cutter shaft
Rubbish in suction
Checked pipe line
Cleaning pump
Pontoon line plugged
Reducing pontoon line
Changing swinging line
TOTAL IDLE HOURS TODAY
WEEKLY PERCENTAGE IDLE WORKING TIME-(ALL DREDGES)
For Week ended 8 A.M. Wednesday 1919
Percentage WORKING TIME (ALL DREDGES)
IDLE TIME Contractor's Liability
" " U.S. Gov't "
Compiled and Reported at end of Government week only
OVERALL % IDLE TIME by Weeks
THIS WEEK ended 8 A.M. Wed Jan. 29, 1919 46.4 % IDLE
LAST WEEK ended 8 A.M. Wed Jan. 22, 1919 62.4 % IDLE
CORRECT
Signed
For Field Engineer

FIG. 11. REPORT FORM FOR DAILY DREDGE PERFORMANCE

The data shown graphically in Fig. 10 represents progress day by day over a period of eight months, in the driving of some 50,000 wooden piles in the piers and the warehouse foundations at the Philadelphia Base. As is seen, with a maximum of 27 piledrivers of all classes at the work simultaneously, somewhat over 2,500 piledriver days were consumed, giving an over-all average of 20 piles driven per day per crew, and a maximum of 638 piles driven in any one day by all crews. On this work of driving piles and its closely related dockbuilding, up to 1,300 men were engaged at one time. The chart shows both the schedule curves and the actual performance curves; in the former, the general formula for scheduled rate of progress was: 15 per cent of the work to be accomplished in the first 30 per cent of time elapsed, 10 per cent of the work to be accomplished in the final 20 per cent of time elapsed, and the rate of progress for remainder of work was to be along a "straight-line curve." How the shape of the actual curves approximated the schedule formula can be observed.

In addition are shown: Daily and average performances of pile driving (as distinguished from cumulative totals), average pile length, percentage wastage due to "cut-off" of pile, and data on number of machines at the job, both active and idle. Certain tabular data complete the chart.

A commentary of engineering interest may be made on the performance of certain large *traveling piledriver rigs* which were arranged for driving land piles from tracks that permitted travel of the driver for 25 ft. in one direction and 100 ft. in the lateral direction. These large machines mounted on trucks could drive some 160 piles without a new set-up of the long 100-ft. tracks, yet their *average* performance over the period during which they were employed was only 38 piles driven per day, their best performance being 90 piles per day. It was to show exactly what conditions were in such facts as these that the Progress Department fulfilled one of its functions in respect to work progress.

Charts of Dredging

The operation of dredging for the deep-water docks at the Base entailed the removal of close upon 2,000,000 cu.yd. of material, and required that two cuts be made because of the depth of final dredging plane. The operation was carried through with as many as four hydraulic dredges at work at one time in the Delaware River, discharging into 300 acres of impounding basins.

In the graphical chart in Fig. 12, is given the daily record of about a year's work of dredging. The two prominent curves are those of yardage dredged daily—a heavy jagged curve, and of total yardage dredged to date. The smooth curve or original schedule on a war basis may be observed, and subsequent schedule revisions. Also, there is the light jagged curve of daily average performance, by weeks.

At the bottom of the chart are recorded also, by weeks, the percentages of working and idle time for all dredges. This resolved itself into *three percentages* which are shown by rectangular areas. These are: Dredge working time; idle time for which the contractor was liable; and idle time for which the Government was liable. A curve of percentage of total idle time for all dredges, taken cumulatively, is seen superimposed upon the three sets of areas just described.

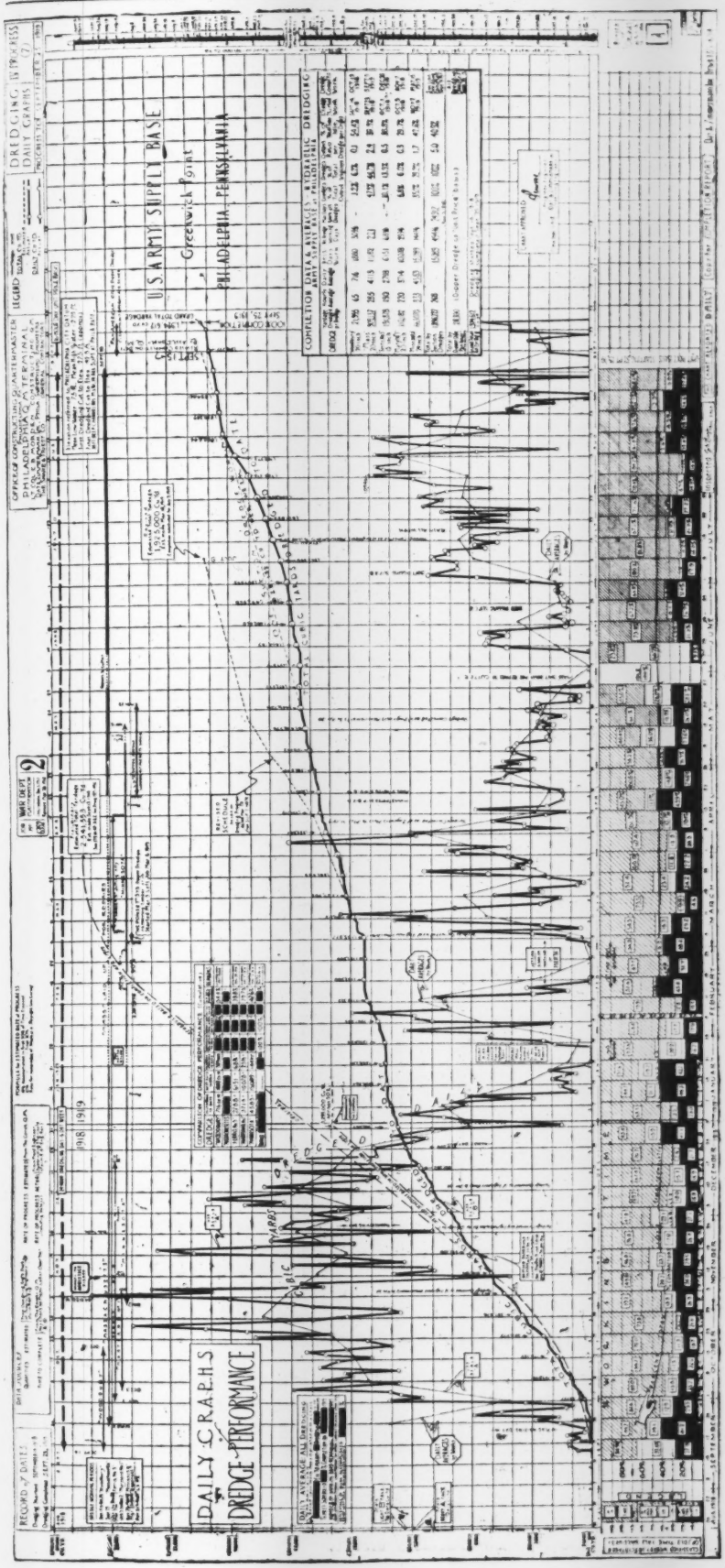


FIG. 12. GRAPHICAL REPRESENTATION OF DREDGING PERFORMANCE ON PHILADELPHIA ARMY BASE

It is of interest to note some of the final averages shown in the table in right of chart: Hourly average, per dredge 268 cu.yd.; best day's work, any dredge 15,089 cu.yd.; number dredge working days 494; maximum day's work, all dredges 24,912 cu.yd.; percentage of total idle time, all dredges 40.9 per cent.

In addition to the graphical chart just described, the Progress Department compiled *progress plans of dredging*. These showed, by means of washes in color, the extent and depth of the cut and the extent and level of the fill. The same plans gave the progress of diking around impounding basins ashore, and of laying pipe lines, often a mile long.

Concrete Work

In order to schedule and follow up the mixing and placing of some 120,000 cu.yd. of concrete in the project as curtailed to the needs of peace, the curves given in Fig. 13 were made use of. The curves for the 1,500-ft. pier "B" show a division into the quantity of concrete placed in the substructure or pier, and the quantity placed in the 3-story superstructure or warehouses. The curves for the 1,320-ft. Pier "C" show the substructure only, because these warehouses were omitted after the signing of the armistice.

As indicated earlier in this article, two kinds of gravity mixing and placing plants were used: Floating plants, and stationary plants ashore. Plant performance curves in terms of yardages poured each week, are given in the lower portion of Fig. 13. Over-all figures at completion occupy the tables that are shown.

To follow up the installation of the heating system, the plumbing system, the fire sprinkler system, and the electrical wiring system, a utilities chart (not shown here) was developed. It expresses in percentages the respective amounts of materials in place in the various sections of the two warehouses, each divided into 300-ft. sections between firewalls, and taken by floors. Over-all percentage completion is indicated in thermometer scales. Actual lengths in place, to scale, are shown directly below the diagram of each warehouse building. Diagrammatic plans of the several system layouts complete the chart.

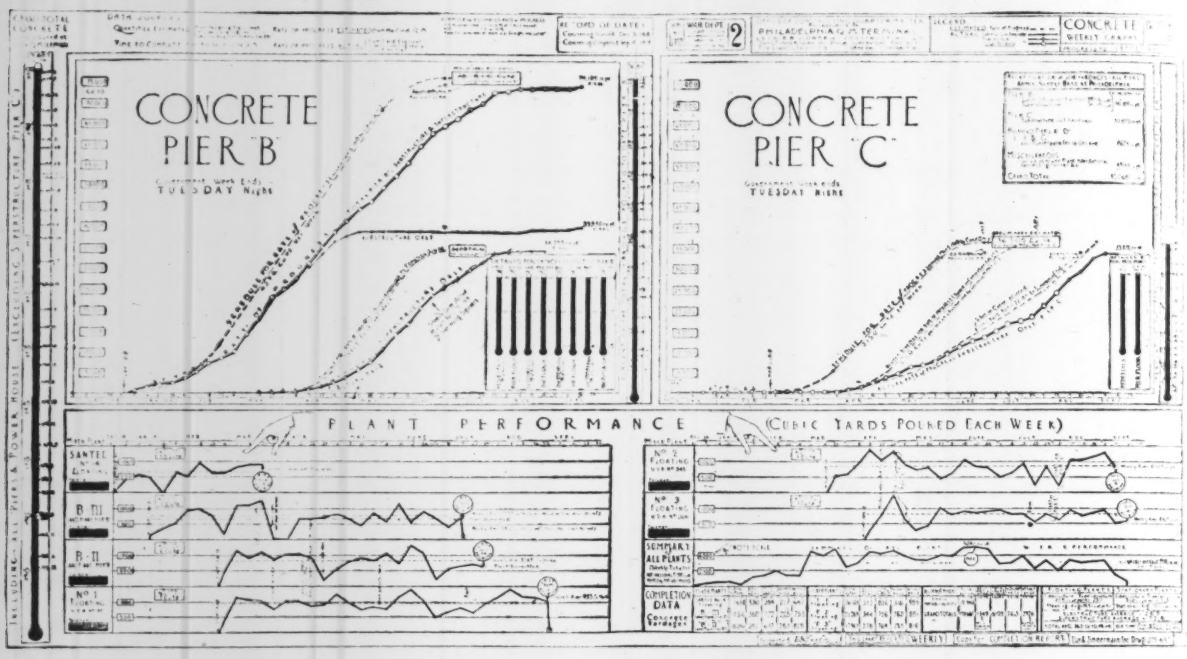


FIG. 13. GRAPHICAL REPRESENTATION OF CONCRETING PERFORMANCE ON PHILADELPHIA ARMY BASE

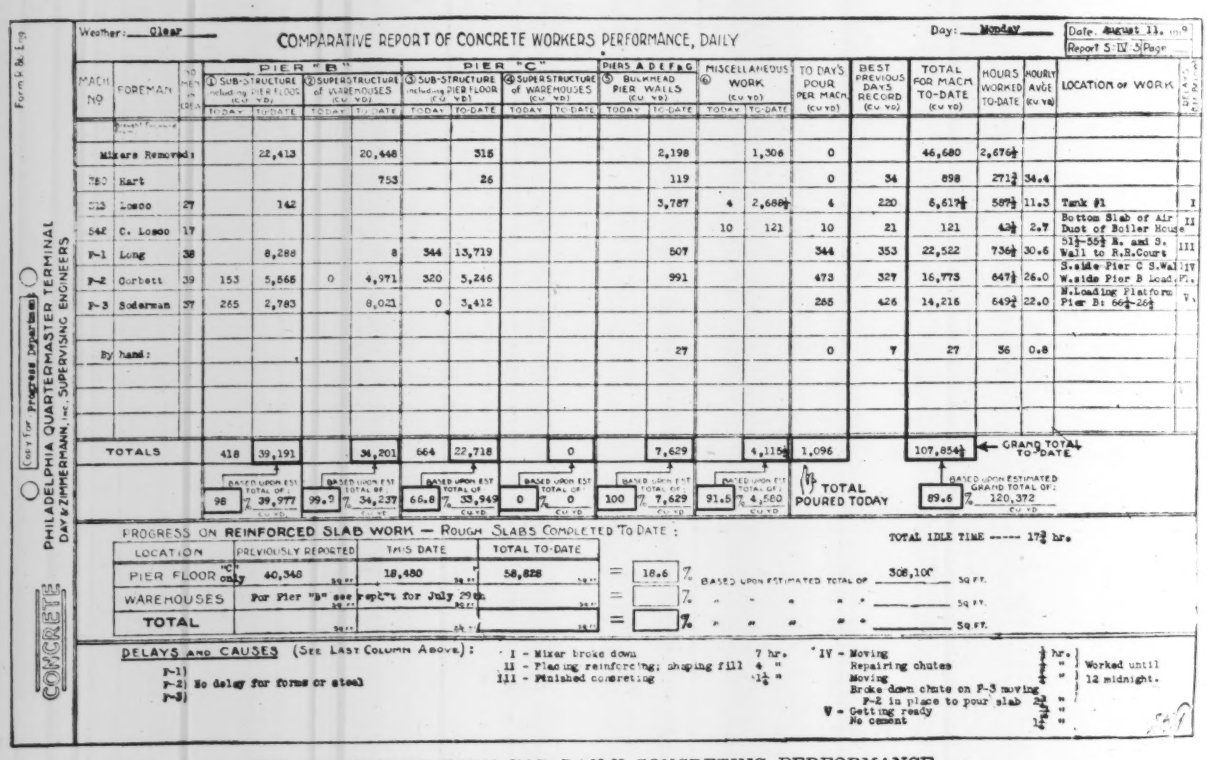

COMPARATIVE REPORT OF CONCRETE WORKERS PERFORMANCE, DAILY
PHILADELPHIA QUARTERMASTER TERMINAL
DAY & ZIMMERMANN, INC. SUPERVISING ENGINEERS
PROGRESS ON REINFORCED SLAB WORK — ROUGH SLABS COMPLETED TO DATE:
DELAYS AND CAUSES (SEE LAST COLUMN ABOVE):

FIG. 14. REPORT FORM FOR DAILY CONCRETING PERFORMANCE

The detail planning necessary to prepare and revise schedules has not been more than touched upon in this article; and adequate description would entail elaboration on many factors and local conditions. Some of the factors considered were: Material situation, labor supply, unit production both of construction equipment and labor gangs, expected weather conditions (based on records of the Weather Bureau at Philadelphia during the past 35 years), degree of protection to some parts of the work against low temperature, special features of construction, working hours, general plant organization, etc. —and always, the analysis made not only of the work as a whole, but of the component parts and their correlation. Conference on these matters between members of the three organizations in the field served well to co-ordinate effort.

The results only, of all of this, are given in the various schedule curves and were found in many detail working schedules not shown.

* * *

Progress work on anything like the scale to which it was carried out at the Philadelphia Base is desirable only to be applied to construction projects of magnitudes that compare with this port terminal development. In the particular case, the gain secured in co-ordination warranted the extensiveness of the report system, and the Progress Charts served as guides alike for the Constructing Quartermaster, the executive heads of the two other organizations in the field, and the headquarters in Washington of the Construction Division of the Army. The charts were made the subject of study in conference at the project.

The reader may have observed that all of the classes of Progress Reports have not been discussed nor reproduced in this article, for reasons which are obvious. And, indeed, permission on the part of the Construction Division of the Army to include those of the charts which have been described is cordially appreciated, and the writer personally wishes especially to make acknowledgment of the Constructing Quartermaster, through whom permission was secured.

More might be written descriptive of the progress work in general at the Supply Base at Philadelphia; it was a work of evolution that required some degree of study of changing conditions at a time when actually every day counted in the stress of military preparation against the Hun. But while more might be set down, it is felt that the charts can best speak for themselves—as the permanent records of an Army construction job which ranks among the big U. S. war projects.

Railway Engineers of A. A. E. Hold Second Conference

Employment, Compensation, Efficiency and Economy in Railway and Public Service Discussed at Chicago Meeting

Fifty railway chapters established in the first year's work is the record of the railway campaign of the American Association of Engineers, as explained at its second railway conference held in Chicago March 15. Engineers' compensation and their opportunities under the new railway law were the main topics of the discussion. Provisions of the law relative to compensation and classification were outlined by the secretary, C. E. Drayer, and a telegram was sent to Washington urging the appointment of C. E. Lindsay as an engineer member of the Labor Board created to deal with matters of compensation.

Relations between railway engineers and railway managements were dealt with in a paper by Major Hill, who stated that the failure to assign proper authority to the engineer has worked against the interests of both the engineers and the railways. Proper relations between the operating officials and the engineering department, it was pointed out, depend upon the following factors: Organization, with the lines of executives and technical supervision clearly drawn; adequate engineering staff and its proper distribution, and assignment of authority and responsibility to the engineer.

In discussing the future railway work of the association, G. W. Hand, Chicago & Northwestern Ry., suggested that the sections should procure and discuss the operating and other statistics of their roads in order to broaden the ideas of the younger men and beginners, showing them how the engineering department is related to the wider phases of railway service. Managements should realize the advantages of changing the department organization as little as possible, so that men may see opportunities of permanent employment and of advancement. This same view of permanency of employment was presented by F. E. Morrow, Chicago & Western Indiana R.R., while J. B. Jenks, Baltimore & Ohio R.R., stated that with such a permanent system the various positions must be graded and qualifications established for each grade.

Classification and Compensation

Classification and compensation of engineers in general was reviewed by a committee from Engineering Council composed of Arthur S. Tuttle, New York; Col. Bion J. Arnold, Chicago; and Oscar C. Merrill, Washington, D. C. Mr. Tuttle presented the classification of professional service adopted in December, 1919, by Engineering Council. He predicted an active period of railway work, with proper financial reward for the engineers. Co-operation between the American Association of Engineers and Engineering Council was the theme of Colonel Arnold's argument.

The serious losses of the government departments by continually increasing resignations of technical men, due to inadequate pay, were touched upon by Mr. Merrill. He suggested that every position ought to pay not only a living wage but also "the amount necessary to secure and retain employees having the training, experience and personal qualities requisite for the effective performance of the duties of the position."

Problems confronting the railways on their return to private control were discussed by S. M. Felton, president of the Chicago Great Western R.R. Inadequacy of railway facilities is the most important circumstance now affecting transportation. During the past 4½ years freight and passenger traffic has increased 45 per cent, while rolling stock and other facilities have increased only 2 per cent.

Plans for future work in the railway field, according to J. R. Leighty, Missouri Pacific R.R., must provide for increasing the value of the engineer's services, selling that valuable service at the highest price and guaranteeing that the employer will get the service for which he pays this high price.

New York's Highway Bridges

In an address before the highway transport conferences given in connection with the National Motor Truck Show in New York City, H. Eltinge Breed asserted that "bridges have lagged furthest behind in improvement, because they are not regarded as an integral part of the highway system. In long roads that are bearing 14-ton loads you constantly meet bridges designed for only 10-ton loads. Mr. Breed asserted that in New York State there are 33,775 bridges, and of a total of 251 on three main traveled routes from the Pennsylvania State line to New York City but 115 are built for 15 tons or over; seventeen and one half per cent of them are built for less than a 5-ton load, and 23 of them would stand less than 3 tons.

Concrete-Beam Diagram with Top and Bottom Steel

Though Mainly for Both Tension and Compression Reinforcement Can Be Used With Tensile Steel Only

By Arthur G. Hayden
Office of State Engineer and Surveyor, Albany, N. Y.

COMMON methods of concrete-beam diagram construction require a set of several diagrams for the complete analysis of concrete beams which are reinforced for both tension and compression. For example, the arm of the resisting couple being a function of three independent variables, (1) the tensile steel ratio, (2) the compressive steel ratio and (3) the ratio of the distance of the compressive steel from the compression face of the beam to the total depth, a diagram for *each* of several values of one of the variables, say (3), is usually given for determining the arm of the resisting couple in terms of the other two variables. For intermediate values of the third variable interpolation is necessary.

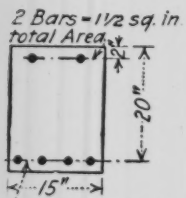


FIG. 1. DOUBLE-REINFORCED BEAM

The accompanying pair of diagrams is so constructed that the following properties of concrete beams with any percentage of tensile reinforcement and any percentage of compressive reinforcement, however located with respect to the compressive face of the beam, may be obtained, viz.:

1. The ratio of the unit stress in the steel to the unit stress in the concrete.

2. The ratio of the distance of the neutral axis from the compressive face of the beam to the total affective depth of the beam.

3. The ratio of the arm of the resisting couple to the total effective depth of the beam.

The stress in the concrete is assumed to follow the linear law and tension in the concrete is neglected. The ratio of the modulus of elasticity of steel to the modulus of elasticity of the concrete is taken as 15.

In the following discussion, standard notation, as indicated on the diagrams, is used. The use of the diagrams is best illustrated by examples.

Required the carrying capacity of a beam, as shown in Fig. 1, in which the tensile steel ratio p is 0.01, and the compressive steel ratio p' is 0.005, the compressive steel being so located that $d'/d = 0.1$.

Values of p are plotted on the left-hand vertical ordinate and values of p' in the right-hand vertical ordinate of each diagram. Pass a straight-edge through the points $p = 0.01$ and $p' = 0.005$ of the upper diagram. At the intersection of the straight-edge with the line $d'/d = 0.1$ read off, on the lines radiating from the point $p' = 0$, $r(= f_s/f_c) = 24.5$. In like manner obtain from the lower diagram $j = 0.88$. The moment

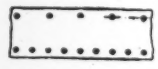
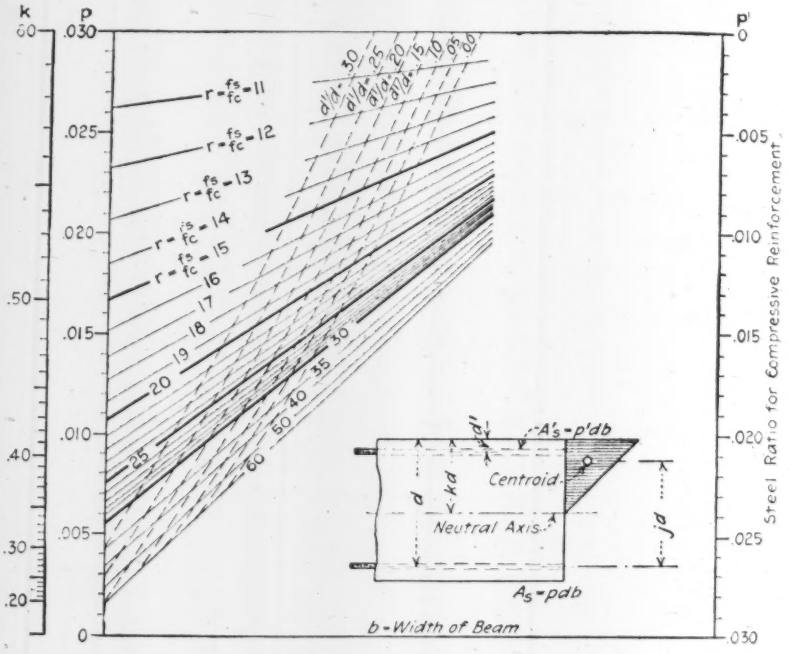


FIG. 2. DOUBLE-REINFORCED SLAB



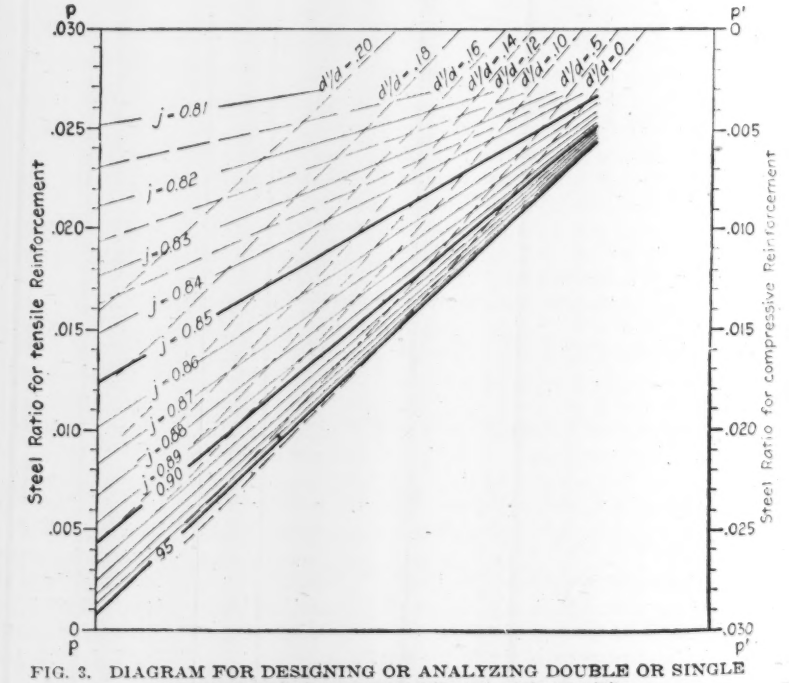


FIG. 3. DIAGRAM FOR DESIGNING OR ANALYZING DOUBLE OR SINGLE REINFORCED-CONCRETE BEAMS AND SLABS

value of the beam, as determined by the tensile steel, at 16,000 lb. per square inch $= 0.88 \times 20 \times 3 \times 16{,}000 = 845{,}000$ in.-lb.

The corresponding unit stress in the concrete $= \frac{16000}{r} = \frac{16000}{24.5} = 640$ lb. per square inch. If the allowable unit stress in the concrete were to be limited to 600 lb. per square inch or $\frac{1}{27}$ of the stress in the steel, the moment value of the beam, as determined by the concrete, would be expressed as $\frac{24.5}{27} \times 0.88 \times 20 \times 16{,}000 = 775{,}000$ in.-lb.

If the value of k is desired it may be found from the upper diagram as follows:

From the intersection of the straight-edge with the proper line of d'/d follow the direction of the r lines (radiating from the point $p' = 0$), to the left-hand vertical ordinate, thence horizontally to the vertical scale for k, from which its value may be read off. For $p = 0.01$, $p' = 0.005$ and $d'/d = 0.1$. k is found to be $= 0.38$.

As a converse problem, suppose a floor slab subjected to an external bending moment of 12,000 in.-lb. per inch width of slab. Design the slab so that the unit stress in the steel will not exceed 16,000 lb. per square inch nor the stress in the concrete exceed 600 lb. per square inch. That is, if $r(= f_s/f_c)$, as found by means of the upper diagram, is less than $\frac{16000}{600} = 27$, the strength of the slab will be limited by the concrete; if more than 27, the strength will be limited by the tension steel.

The general details of the slab are to be as shown in Fig. 2. Use reinforcement as follows:
$p = 0.01$, $p' = 0.005$. Assume tentatively $d'/d = 0.15$
Find, from the upper diagram, $r(= (f_s/f_c) = 24$, hence the unit stress in the tension steel must not exceed $\frac{24}{27} \times 16{,}000$ to give 600 in the concrete.

From the lower diagram $j = 0.866$

$$\frac{24}{27} \times 16000 \times 0.01d \times 0.866d = 12000$$

or $d = \sqrt{97} =$ say 10-in.

Actual $\frac{d'}{d} = \frac{1.5}{10} = 0.15$ as assumed hence no correction to the computation is required.

The upper diagram for obtaining k and $r(= f_s/f_c)$ is constructed mathematically and involves no approximation. A mathematically constructed diagram for obtaining j in terms of p, p' and d'/d is more complicated in form and not so simply operated. A slight approximation was therefore made in constructing the diagram to bring it into the convenient form here shown. The resulting error in the value of j, obtained from the diagram, will not, however, amount to more than 0.001 or 0.002, and that only for unusual proportions of reinforcement.

The Population of the Berlin District

The census of the metropolitan district of Berlin, Germany, begun Oct. 9, 1919, showed a population of 3,801,235. A decrease of 54,000 males and an increase of 125,000 females in Greater Berlin is attributed to the war.

Highway Classification Undertaken By Bureau Public Roads

Co-operation of War Department, State Highway Departments and Local Interests Sought in Work

A SYSTEMATIC program of highway development has been outlined by Thomas H. MacDonald, chief of the U. S. Bureau of Public Roads. Since taking over the direction of this bureau, nearly a year ago, Mr. MacDonald has made a careful study of the situation from a national point of view. As the head of the agency which is directing the expenditure of millions of dollars on Federal-aid projects he occupies a position of vantage which attaches particular importance to his conclusions. Some of his views are expressed below:

For the past several months it has become increasingly apparent that a comprehensive study should be inaugurated by the Bureau of Public Roads of the functions served by improved highways, that a proper program of highway development may be planned, which involves the following features:

First, the classification of highways into systems based primarily upon the different classes of traffic, present or prospective, to be carried.

Second, the relative importance of the various classes of highways as to the national, state, county and local needs as modifying the sequence and rate of improvement.

Third, the correlation and adjustment of highway systems between contiguous localities and states.

Fourth, the distribution of the costs of improvement of the several systems.

The importance of such a study has been emphasized by the contact which has been brought about by the co-operative work already done by the bureau and the state highway departments of the several states. It is already well established that the rate of highway improvement, because of economic factors which are not within the control of either state of Federal agencies, will be much slower than the public is now demanding. Regardless of the amount of funds made available for use in building roads the rate of road production will be determined by the resources, transportation, materials, labor, contractors, equipment and engineer forces that be placed on this work and devoted to this purpose without disrupting other vitally necessary economic demands for the same resources. There must come a realization that only a percentage of the resources demanded for increasing the rate of road production can be provided for this purpose, and so the production of roads must be studied and programs determined the same as for any large industrial undertaking, and in order that the roads which meet the greatest economic needs will receive first consideration.

Co-operation of All Agencies Needed

Roads are fundamentally of local concern, and inevitably if left to local demands an orderly program of highway improvement cannot be developed. It is, therefore, one of the functions of the state and national departments to formulate programs and determine the sequence of construction in order that this work of highway improvement may proceed in an orderly manner and those needs which are of greatest economic importance shall be first fulfilled. In order to do this there

must be co-operation between the following agencies—the Bureau of Public Roads, the War Department, the several state highway departments, and other similar agencies representative respectively of the National, state and local needs. Up to the present time considerable initial progress has been made, particularly in establishing co-operation with the War Department and also with the Geological Survey Department of the Interior.

Early in August, 1919, the first of a series of conferences was held with the officers of the War Plans Division of the General Staff of the War Department relative to a study of the highways of the United States with reference to their importance from a military standpoint. At the first conference a preliminary agreement was reached covering the following points:

(a) The roads which must be constructed for commerce and national development will in general be identical with those required for military purposes.

(b) The roads which serve mainly military purposes are comparatively few in number. Such roads as are required to serve the local needs of military posts, cantonments, supply depots, arsenals, etc., should be taken care of by the War Department.

(c) The Bureau of Public Roads will prepare and furnish the War Plans Division, to be used in connection with the study to be made, copies of the latest available state road maps.

(d) The Bureau of Public Roads will also prepare and furnish the War Plans Division a copy of the district organization of the bureau, giving the location and names of local district engineers with whom the Department General Staff sections may confer concerning the development of roads within the department.

(e) These district engineers will be given instructions by the Chief of the Bureau of Public Roads to assist the Department General Staff sections in every possible way in the preparation of the department road projects.

(f) To assist the Department Commanders in the preparation of the department road projects, the War Plans Division will furnish each Department Commander with a copy of the state road map, furnished by the Bureau of Public Roads, which pertain to his department.

(g) The Chief of the Bureau of Public Roads is willing to confer with the Chief of Engineers as to the classification of roads for military purposes, and co-operate with him in determining types of construction, loadings, culverts, bridges, etc., to meet military requirements.

(h) Upon the completion of the study by the War Plans Division and its approval by the Chief of Staff, the War Department will furnish the Secretary of Agriculture an outline of the system of roads which it is desired to have developed for military purposes. The district engineers of the Bureau of Public Roads, using the War Department project as a basis, will then promote in each state, as a part of the general project of road development, and by co-operation with the local highway commissions, the construction of those roads indicated by priority in the War Department project.

In accordance with this preliminary agreement the latest available state road maps were secured from the state highway departments and furnished to the General Staff of the War Department. In asking the state highway departments for the maps a brief outline of the co-operation arrangement with the War Department was given. Replies from the states indicate a willingness and desire to co-operate in the improvement of such highways as may be selected because of their possible future military importance.

Map Preparation Undertaken

Up to date, road maps have been secured from all the states except Arizona, Florida and North Carolina, and it is expected that these maps will be received soon. Also several conferences have been held with officers of the Corps of Engineers, War Department, on classification of highways and specifications necessary to meet military requirements.

At the outset it was discovered that considerable difficulty would be met by the General Staff in making the study because of the great lack of uniformity of the best available maps. It was found that the maps varied in scale and amount of detail shown from a very complete map of one state, on which all roads, classed as primary, secondary and local were shown on a scale of 6 mi. to the inch, to a small, no-scale, blueprint map of another state showing only the primary highways.

Steps have been taken to provide a set of state road maps which will show the present state and county or primary and secondary roads. The U. S. Geological Survey has prepared base maps on a scale of 1 to 500,000 for all but 13 states. It is expected that within a year these base maps will be available for all the states. By using an overprint on the existing base maps a very satisfactory road map can be produced at a comparatively low cost. It is proposed to prepare these state road maps through a co-operative arrangement with the U. S. Geological Survey. Satisfactory tentative arrangements have been made with the Geological Survey covering this proposed work. Under this tentative arrangement the work is to be done under the immediate supervision of the Geological Survey experts but will be under our general supervision. This appears to be the logical and efficient way to carry this work on.

Owing to the lack of funds the Geological Survey was obliged on March 15 to discharge certain of the personnel needed on this map work. In order that the preparation of these maps may not be delayed, and trained personnel lost, recommendations have been made for the transfer of seven Geological Survey employees to the Bureau of Public Roads, for the period of 4 months, effective March 1.

Concentrate on National Highway

While the maps prepared under the foregoing arrangement will not be available in time to be of use in connection with the study being made by the General Staff of the War Department, they will serve many other useful purposes and are urgently needed, particularly in connection with the administration of the Federal-aid act.

At the convention held in Louisville, Dec. 8 to 11, 1919, by the American Association of State Highway Officials, a resolution was passed urging the continuation of Federal co-operation in road building under the terms of the existing law which contained this clause: "That we favor an adequate national highway system upon which the Federal-aid funds will be concentrated. This system shall be selected by the various states in co-operation with the Bureau of Public Roads, and connected at the state lines by the Federal departments in cases

where connections are not made by the adjoining states."

It is proposed to inaugurate a comprehensive study of the highways of the United States in co-operation with each state highway department for the purpose of determining a proper classification of all roads into groups of equal or like importance and of correlating the systems of one state which are of more than local importance with systems of equal importance in the adjoining states. With the completion of the proposed uniform scale maps a tentative selection of a national system of highways will be made on which it may be desirable to give preferential consideration in the allocation of Federal aid. No recommendations have as yet been received from the War Department relative to the roads important from a military standpoint. These will be received in due time, however, and will be given very careful consideration in connection with the selection of the system as proposed by the Louisville resolution.

Law of Supply and Demand as Applied to Engineering Service

The general policies under which the accomplishments of the American Association of Engineers in the railroad field have been obtained (estimated at $5,000,000 increase annually) are based on the law of supply and demand. D. A. Tomlinson, secretary of the railroad department, defined the policies and gave the results before the Second Railroad Conference of the Association as follows:

" 'To promote the economic and social welfare of engineers' means, in the final analysis, to secure higher salaries for engineers. Primarily those salaries are controlled by the law of supply and demand, whose action is inevitable. A combination of forces can postpone but cannot prevent its application. But its application varies with conditions, and those conditions can be influenced by proper methods so as ultimately to benefit the men or the organization using them. Engineers are familiar with the law of supply and demand and with its application, but they seldom appreciate the conditions on which its application is based or the factors that influence those conditions. Those conditions and those factors are appreciated and are well understood by the sales and advertising departments of large corporations and in the railroad campaign A. A. E. adopted the methods used by such concerns.

"To limit the supply of engineers would force salaries up but to do so would be difficult. Furthermore, such action would be fundamentally wrong and would irretrievably injure the engineering profession. To increase the demand for engineers is a difficult proposition but it is fundamentally sound. Good engineering service is of great value and a greater use of good engineering talent will benefit the entire country. Therefore, the question is, 'How can the demand for engineering service be increased?' or in other words 'How can the market for engineers be broadened?' For an answer, turn to the sales campaign of any large corporation: for instance how was the market for the Gillette Safety Razor developed to its present proportions? By a campaign to educate the jobbers, the dealers and the public to an appreciation of the advantages of a safety razor. Advertising leaflets, newspaper stories, lecturers and salesmen were all employed. Similarly, a campaign of education conducted along proper lines will develop the market for engineers. That campaign must be directed so as to reach the proper men, and its fundamental sincerity and worth must appeal to them."

The following is an estimate of the average monthly salary increases obtained: Northwestern Region, $40; Central Western Region, $30; Southwestern Region, $40; Southern Region, $5; Pocohontas Region, $20; Allegheny Region, $15; Eastern Region, $10.

"There are approximately 20,000 railroad professional engineers in the United States. Their average increase in salary as a result of A. A. E.'s work is estimated at $20 a month, or a total increase of $5,000,000 a year. The total cost of this work to A. A. E. has been somewhat over $7,000. Thus an investment of $7,000 collected through organized effort and expended wisely, is paying dividends of $5,000,000 a year to railroad engineers. That appears to be a rather profitable investment. Based on statistics presented to Congress by the Director General the average pay of assistant engineers and draftsmen in 1917 was $95.40 a month, and in July, 1919, before the application of the increases secured by A. A. E., $138.96 a month, an increase of 44 per cent. These new increases secured by A. A. E. bring the estimated average pay in December, 1919, up to $160 a month, or an increase of 68 per cent over 1917 salaries."

Tests of Earth Subsidence Under Fills

(Abstract of Committee Report, American Railway Engineering Association.)

Subsidence of soil under the weight of railway fills appears to be a general condition, existing to some extent under all such fills, according to the report of the roadway committee of the American Railway Engineering Association, whose conclusion is based upon an investigation covering several hundred miles of line. Not only was grading material found, but also quantities of cribbing, mattress work and timbers. The subsidence appears to average one per cent per foot of height of fill.

In determining the amount of subsidence, trenches are made only through light fills and at the toes of larger fills. Auger borings are made where the material is such that the auger will bring it up. A protective pipe or casing is driven usually through the loose material, the auger being operated through this. Wash borings are made when the depth is too great or the material is unsuitable for auger borings.

Cross-sections are taken at such intervals as are considered necessary in view of the character of the surface, there being usually test holes at the center and on the slopes, and possibly in the middle of the fill. From these tests the surface of the original ground is located, while from the notes taken a cross-section is plotted and the yardage calculated in the usual way. After the subsidence is calculated, a percentage should be added for shrinkage, which the committee has found average ten per cent. The testing party consists usually of an engineer, a foreman and three helpers. It is given usually a boarding car outfit, which is moved from place to place in local freight trains.

In the cost of such tests there should be included equipment, material, labor, personal expenses, transportation and overhead, but none of the roads reporting gave the cost of transportation. The costs given ranged from 33c. to 55c. per foot of hole bored. The committee calls attention to the importance of due consideration being given to the matter of subsidence when revaluation surveys are made.

HINTS FOR THE CONTRACTOR

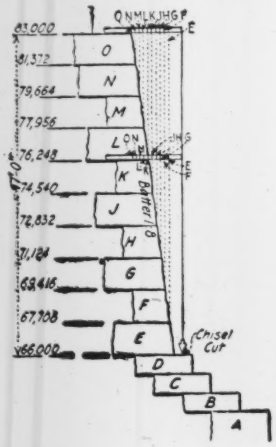
DETAILS WHICH SAVE TIME AND LABOR ON CONSTRUCTION WORK

Device Maintains True Batter in Masonry Wall

By H. D. Hurley

Assistant Engineer, Massachusetts Department of Public Works

THE apparatus shown in the accompanying sketch was used in the construction of the drydock recently completed at Boston by the Massachusetts Department of Public Works, Division of Waterways and Public Lands. The walls of the drydock are concrete faced with granite masonry. The first rise was built as indicated, the length of wall of this type being approximately 2,000 ft., built in sections about 60 ft. long. The apparatus shown consisted of a stick of light wood 2 in. x 3 in. x 4 ft., with the four sides smooth. It was notched at the horizontal projection of the batter of each course from the toe of the wall, plus 6 in., and notched on the top to hold a plumb-bob string. The chisel cut was placed by the line and level party every 60-ft. section



To use the device the stick was placed on top of the stone to be laid with the mark for that course on the batter line. The stone would then be in its correct position when the plumb bob was directly above the chisel cut. A line stone was set for each course at the ends of every 60-ft. section, intermediate stones being set by eye.

Two Sets of Plans for Contractor

By Edward W. Bush

Hartford, Conn.

THE practice has become quite general of requiring the contractor to make a payment or deposit before obtaining a set of the plans and contract form, and I suggest that it will be of great advantage to all concerned if engineers furnish the contractor with two sets of the contract and plans instead of one for the same fee or deposit, and to so specify in advertisement for bids.

In nearly every case, contractors are arranging with their bonding company to write the bond, providing they are successful bidders, at the same time that they are making up their bid. It is often of considerable advantage to the contractor if he can forward the plans and contract to the surety, as he is always interested in knowing what the obligations are as well as the character of the work to be performed, etc. Especially is this true when large contracts are let, or when the contractor already has a considerable volume of work under way for the size of his organization or the amount of net quick assets shown in his financial statement. Anything that helps a worthy contractor to make up his bid and arrange for his bond with a strong surety company, helps the business of construction.

Quick Field Punch for Bridge Work

By C. J. Bennett

State Highway Commissioner, Hartford, Conn.

THE illustration shows a casting hinged in the middle by the use of two bolts which can quickly be removed, allowing the casting to be slipped over an I-beam, channel, or other structural shape. In the lower part of the casting is placed a die for a punch and to the upper part is bolted a ball-bearing screw device holding a punch to fit the die. This device has been used in Connecticut and proved of value in getting quick action in punching holes in structural shapes. The illustration shows plainly the operation of the machine by a capstan-head screw actuated by a long bar. The device was developed by A. R. Doe, bridge supervisor in the Connecticut Highway Department. In order that it might be photographed, it was placed on top of a post.

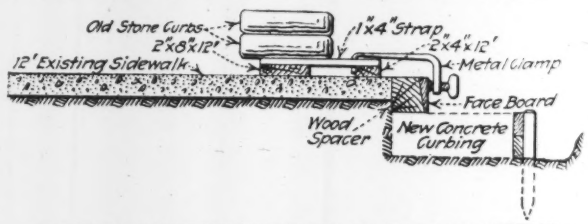
HAND-POWER PUNCH USED FOR BRIDGE STEEL IN WORK

Hanging Forms for Curb Work

By D. H. Fleming

Town Engineer, Owen Sound, Ont.

ON a recent contract for concrete curbing work the contractor was required to remove an old flagstone curb joining a 12-ft. sidewalk, making it impossible to stake the back forms. He therefore laid a plank along the sidewalk near the edge and weighted it with the old flagstones. The forms were clamped to this strip as shown in the sketch. The method proved very convenient and economical as the back form was not then required and the flagstone weights were close at hand.



SECTION, SHOWING METHOD OF HOLDING FORMS

LETTERS TO THE EDITOR

Comment on Matters of Interest to Engineers and Contractors Will Be Welcome

Society of American Military Engineers

Sir—Your editorial "Soldier-Civilian Co-operation" in *Engineering News-Record* of March 4, p. 450, goes to the very heart of the purpose underlying the organization of The Society of American Military Engineers. This organization is devoted to the formulation of a rational policy of military preparedness, and it seeks to bring under one roof all engineers and others of suitable technical qualifications who have served at any time in any capacity—military or civilian—in any arm, department or service of the military forces of the United States.

Your editorial makes reference to the need of a democratic organization of engineers; this the society aims to be. Eligibility to membership is as comprehensive as the engineering profession itself, and the basis of the government of the society is as democratic as is the obligation on every citizen to actively assist in the national defense. There are no distinctions based on military rank or on civilian reputation; the "buck private" and the general officer have equal rights and privileges with the civilian, neither more nor less, and these rights and privileges are guaranteed by the constitution and by-laws.

The provisional constitution mentioned in your news column Feb. 19 has been recast and active membership is now open to all technical engineers—civil, electrical, mechanical, mining and others—in the military service, whether in a uniformed or a civilian capacity. The government of the society is vested in a Board of Directors consisting of a president, two vice-presidents and eighteen others, all of whom are elected by direct vote of the active members. The three officers first named serve for one year only, and none of them is eligible immediately to succeed himself in office. There are no restrictions as to eligibility for office other than that six directors must be chosen from the Regular Army (Corps of Engineers, Ordnance, Signal Corps, and other technical services); six from the other military forces of the United States subject to active duty, and six from the membership at large exclusive of the foregoing two groups. The term of office for all directors is three years but the usual arrangements obtain whereby the term of office of two directors of each group of six expires each year.

There is no society of engineers known to the writer whose basic organization is more democratic or more responsive to the will of its members than is the Society of American Military Engineers. In the interests of democracy the dues ($4.50 for the current year) are merely nominal, and so low as to prevent no person from joining who is eligible to membership. The only restriction that now obtains in the organization of the society is that the secretary and the editor of the *Journal* shall be officers of the Corps of Engineers. This is a provision of the by-laws, and it is in the interests of the society that these two positions shall be filled by professional military engineers.

Due to the fact that the officers are not paid but must conduct the affairs of the society in their spare time and due also to the fact that funds are limited, it has not been possible up to date to give the formation of this society the publicity which its principles merit. However, requests for information and applications for membership are being received in numbers which indicate that the citizen-soldier-engineers believe this organization has a distinct field of usefulness, and that it can be of real service in the scheme of national defense.

The acting secretary, Major P. S. Bond, Corps of Engineers, Washington Barracks, D. C., or the undersigned will gladly answer inquiries concerning this society.

G. A. YOUNGBERG,
Colonel of Engineers,
Room 2701 Munitions Bldg.

Washington, D. C.

A Grade Engineer

Sir—Among the many applications that have been filed with we for positions since our state decided to build $25,000,000 worth of roads is the following. It was so amusing to me that I thought perhaps you might like to publish it.

"Mr. W. S. Kellers, Montgomery, Ala. Dear sir I am asking you if you can give a man a job on the Civil Engineer Forces on the Public Roads. I can run an instrument the same as any one. I have got some fine grades laid down on the public roads out here. I hope to hear from you. Say if you can please tell me what you pay Civil Engineers per day, for work on the road with their instruments. Thanking you in advance."

W. S. KELLER,
Engineer, Alabama Highway Dept.

Montgomery, Ala.

Highway Foundations and Drainage

Sir—I consider I. W. Patterson's methods of road construction, as explained in *Engineering News-Record*, Dec. 11-18, 1919, to be the best I have ever read, especially since they have actually been applied. I am certain that no matter what kind of material is contemplated being used as a wearing surface, the preparation of the foundation upon which it is to rest deserves the same careful consideration that Mr. Patterson has applied to the construction of Rhode Island's macadam roads.

I have been engaged in engineering work for the past 19 years, most of which time has been spent in the heart of the brick industry, and I have been a keen observer of the methods used in the construction of roads in this and other sections. Going back to the time when it was a hard job to get the consent of the property owners to build improved roads the question of cost was certainly an extremely important one. There is where some of our poor road construction got its start, because at that time there was such keen competition between manufacturers of surfacing materials that the one showing the least possible cost usually got the business. In endeavoring to show as small a cost as possible these manufacturers employed engineers to design roads according to their own ideas. I think in a great many cases the officials, whether county or state, in their desire to get these roads under way, accepted and used these different designs in the construction of roads with but little investigation.

The worst of it is that since public opinion has changed with respect to improved roads and the people are demanding improved roads regardless of cost, some of the designs of roads which have proven very unsatisfactory are still being used, instead of each new road job being given its deserving individual study and attention.

In this state we have miles and miles of all kinds of improved roads of a standard design, no special attention having been given to the various subsoils and drainage.

Mr. Patterson's article, and especially the feature of foundation and drainage of any type of improved road, cannot be given too much study and attention for the time is surely here when the present methods of road construction are in need of a complete change.

Canton, Ohio. L. K. ZERBE.

Computations for Track Turnouts

Sir—The method for computing split-switch turnouts given by Mr. Ratcliff in *Engineering News-Record*, Feb. 12, p. 341, is in general accordance with modern practice, but certain modifications will result in a more accurate solution.

(1) Computation of radius of outside lead curve:

$$ed = \frac{cf}{\cos S - \cos F} = \frac{cf}{2 \sin \frac{1}{2}(F+S) \sin \frac{1}{2}(F-S)}$$

If the ordinary five-place tables of natural functions are used, the first formula, involving the expression *cos S–F* often results in a value of *ed*, which is not within several feet of the correct value. Computation by the second method, using logarithms, involves very little more work and insures a correct result.

(2) Computation of lead distance from actual switch point to theoretical frog point:

$$zg = ed \sin F - ed \sin S + dg \cos F + ac \cos S$$

This formula, given in Mr. Ratcliff's letter, requires the use of the radius *ed* of the outside rail. As shown in (1), the value of *ed* may be in error (if *cos S–cos F* is used) and the value of the expression *ed sin F–ed sin S* may therefore be incorrect by an inch or more. The use of the term *ac cos S* is an unnecessary refinement, since its value is practically the same as *ac* for all ordinary turnouts; the maximum difference is ½-in. for turnouts, the plans of the American Railway Engineering Association.

In order to eliminate the necessity of using the radius *ed* in computing the lead, the following solution is suggested:

Theoretical lead $zg = ab + jg + fd$

$ab = ac \cos S = ac$ (approx.) $jg = dg \cos F$

$$fd = \frac{cf}{\tan cdf} = \frac{G-(bc+dj)}{\tan \frac{1}{2}(F+S)} = \frac{G-bc-dg \sin F}{\tan \frac{1}{2}(F+S)}$$

Then $$zg = ac + dg \cos F + \frac{G-bc-dg \sin F}{\tan \frac{1}{2}(F+S)}$$

Actual lead equals $zg + nb$, in which n is the frog number and b the thickness of the frog point (generally ½-in.).

I agree with Mr. Ratcliff that the engineer need pay little attention to the turnout details in the field. A track foreman should be able to construct a turnout from the standard turnout plans, after the engineer has located the frog.

The discussion opened by Mr. Scott's letter in *Engineering News-Record*, Oct. 9, 1919, p. 711, as to the degree of curve to be used beyond the heel of frog is of interest. Unquestionably there is no *requirement* that the radius beyond the heel of the frog should be the same as that of the lead curve (either for stub or split switches). There are many cases, however, in which simplicity may be attained by choosing the degree of curve beyond the heel of the frog with some reference to the turnout. If the curve beyond the frog leads to a ladder track or siding, its length is often not great and the exact radius is relatively unimportant. In such a case the most satisfactory curve to use is the one which involves the least computation and fieldwork.

Where great accuracy is not required the stub switch curve is convenient. This method involves the assumption that the curve starts at the frog point instead of at the heel of the frog. The computation of track layouts involving curved ladder tracks and similar problems becomes very complex unless reasonable approximations are made. Considerable ingenuity may be displayed in the choice of proper curves, so that the solution may be kept simple.

In many railroad offices, trackwork is designed by "rule-of-thumb" methods, with constant use of the drawing board when the computations get too complicated. To avoid the maze of figures which often appears in computations of this sort, the designer should understand the fundamental principles of curves and switches so clearly that he may safely apply the slight approximations which simplify the work without impairing the accuracy of the result.

J. B. BABCOCK,
Assistant Professor of Railway Engineering,
Cambridge, Mass. Mass. Inst. of Technology.

"Brass-Band" Bond Voting

Sir—Having followed municipal engineering for a number of years prior to engaging in the municipal bond business I have been more or less in direct touch with construction costs of all classes of public improvements for twenty years, and I have been very much interested in the splendid discussion of this subject by your subscribers. I will then take the liberty of addressing you upon this subject which is in my opinion the most vital we are facing today.

Recently I negotiated for the purchase of a large bond issue for drainage and the reclamation of seeped lands in Utah. The engineers had very wisely made liberal estimates knowing that the lowest bid to be expected would cover the many possibilities of advances in material and labor. The work was offered to competitive bids and the lowest was within the estimates. But the commissioners refused to make the award, basing the refusal on the theory that if the work was let on any such extravagant basis, the contractor could afford to pay extraordinarily high prices for labor and the prices he offered would become the standard for the community, thereby either robbing the farmers of the possibility of securing labor, or driving them to meet the prices set by the drainage contractor. It seems to me this simple case will fully cover the entire scope of in-

flated prices not only for labor but also for material. The contractor who is getting a high price for his work can outbid the contractor who has taken work at a moderate figure.

There is but one solution, and that is to issue fewer bonds for improvements, reduce the amount of public work to conform to the available labor and material supply. The law of supply and demand must govern in this as well as in every other line. The prices being paid for road work not only do an injustice to the taxpayer in giving him about one-half justly due him, but when the work is awarded to the contractor at those prices he raises the prices for labor and materials, disrupts the general scheme of things, reduces farm production, and the farmers' income generally.

Restrict the bond issues to those absolutely necessary for city and civic needs. Place the franchise in the hands of those who pay the taxes. Abolish this brass-band policy of voting debt for roads where no provision is made for the maintenance of expensive highways.

Kansas City, Mo. W. P. BULLOCK.

Economics of Highway Transport

Sir—The article on highway economics, your issue of Feb. 19, p. 383, by George F. Syme, supervising engineer for the North Carolina State Highway Commission, is so apropos that the writer cannot refrain from calling further attention to it and to your editorial comments thereon. Those interested in better highways who have neglected reading it should turn to the aforesaid number of the *News-Record* and catch the point of view that Mr. Syme has so effectively presented. This article should be placed in the hands of every highway engineer, highway commissioner, road promoter, and official of the various highway and kindred associations; because many have yet to realize that a good pavement does not necessarily make a good road, and that poor alignment and a saw-tooth profile do not promote economic transportation. The present-day need for an economic theory of highway transportation is so urgent that construction work might better be held in abeyance than that time be lost in developing and perfecting such a theory. Without an economic theory for a guide we are today groping our way while spending millions of dollars annually for improvements that will, in varying degrees, fall short of giving the desirable maximum economy.

The development of an economic theory for highway transportation follows certain well-defined lines and is similar in its general aspects to the development of an economic theory for any other human activity. The program for procedure would follow four basic steps, viz.:

1. Forming a complete and definite concept of the object to be attained.

2. Determining and classifying the various factors which produce or in any way affect the objective.

3. Determining the quantitative relation between each factor and the desired result, or objective.

4. Determining from the aforesaid relation, one or more interrelations among the factors, such that maximum economy will result.

It is these interrelations, or criteria, that form the economic theory.

The first and second steps can be accomplished quite readily at this time. The third step requires more data than now is available, while the fourth step requires the analytical turn of mind with vision and imagination to perceive relations and to associate ideas. There are many such in the engineering profession. The thing most needed today is research work to secure missing data.

Some of the sought for relations pertaining to the third step can be formulated now. Others are not so obvious. There are at least 9 independent variable factors which affect one or more of the 21 cost items which compose the unit cost of transportation. The writer has so far tabulated 54 relations, or functions, which need to be formulated. Some of these are readily discerned, while others need experimental data for their development. Some of the latter are:

1. Relation between the cost of maintaining power plant and vehicle, and the amount of mechanical work which the truck does on the highway per annum.

2. Relation between rate of wear of road surface and the number of passages of standard wheel load at standard speed.

3. Relation between other wheel loads and speeds to the aforesaid standard wheel load and speed.

4. Relation between cost of maintenance and curvature.

5. Relation between cost of maintenance and tractive resistance.

To secure the needed data, a research program should be prepared by a joint committee representing the various associations interested in highway development. The work involved in executing such a program should be distributed among such agencies as are equipped to carry on the desired investigation and experimental work.

While the results of such research would primarily be for the use of the joint committee in furthering the development of an economic theory, yet the data should be made available as rapidly as possible to the engineering profession, in order to stimulate interest in the goal to be attained and to induce others also to undertake the work of analysis and deduction. This would provide a valuable independent check, and would eliminate quickly faulty conclusions, thus leaving an unassailable residue of criteria.

With a huge road program facing this country, what would it be worth to have such economic criteria available now? Would any private corporation undertake an investment of that magnitude upon as an inadequate basis as highway construction is now conducted?

Kansas City, Mo. ROBERT C. BARNETT,
Economic Engineer.

"Let It Be a Technical Society—Nothing Else"

Sir—Since I resigned from a salaried position in 1915, I have been giving a part of my energies, without compensation, to public affairs, welfare work, etc.

I desire through your columns to say to the membership of the American Society of Civil Engineers which honored me by electing me a vice-president of the society, that from the experience so gained I believe that the American Society of Civil Engineers cannot effectively be "butcher, baker and candle-stick maker." It is a technical society, and as such has honor and weight. Let it be a technical society and nothing else—the best of its kind.

In my opinion the willingness which every ablebodied engineer should have, to give time and service for the

betterment of civic affairs and human relations, can achieve definable action and can be made more effective by support of the Engineering Council in civic affairs, as at present, and by taking an active interest in the American Association of Engineers, a going association, principally concerned in welfare work, and the interest of all professional men will best be served by leaving the American Society of Civil Engineers to continue to gain honor for the profession in its own proper sphere.

Vote "NO" on all questions, in order that the Society may be unhampered in any internal betterments which may be needed.

FRANCIS LEE STUART,
Consulting Engineer.

New York City.

Against Participation by Am. Soc. C. E. in Non-Technical Activities

Sir—During the recent weeks the undersigned have been trying, through a study of the several reports on the subject, through the editorial expression of your paper and through the letters that you have published, to arrive at some definite conclusion concerning the controversy that now prevails in the American Society of Civil Engineers between those who believe in an extension of the society's functions and those who would adhere to the ideals and principles of the society as expressed in its present constitution. The advocates of the proposed changes seem to base their argument on an assumption that it is possible for the society to undertake these new activities without prejudice to the purposes it has fulfilled heretofore and to which it owes its present position. We believe this assumption to be entirely unwarranted and impossible.

Since its foundation in 1852 the American Society of Civil Engineers has striven to make real the conception of its purpose as expressed in its constitution. The society is pledged to the "maintenance of a high professional standard among its members." It has thereby assumed a responsibility to the outside world for the professional standing of its members. It is out of that policy that its strength has grown; to its adherence to that principle it owes its unique and enviable position in the eyes of the world. That this viewpoint and this principle still mean something to the young engineer is demonstrated by the fact that last year witnessed the largest number of new applications for membership in the history of the society.

"A high professional standard among its members." When the founders struck that note they were not thinking of the material things they were going to get out of the Society. Far from it. They were thinking rather of the responsibilities they were to assume; of the service they were to render, not only to their calling, but also to the public. They were seeking to set up ideals that should elevate their calling to the dignity of a profession. Since that day these ideals have governed the doings of the society.

The activities in which it is now proposed that the society shall engage are not in harmony with those conceptions. They are so different, indeed, that it is our conviction that they can never exist simultaneously in any one society. The two ideals will never mix.

The first is to "maintain a high professional standard"; the spirit is one of responsibility and of service. The second is to foster the welfare, and look after the non-technical interests of the engineer. The two motives are born of diametrically opposite instincts, both natural and both necessary, but still as far apart as the poles in spirit and in practice.

If the society shall try to advance under such a dual standard and with so divided and discordant purposes, it must fail miserably. One or the other will prevail. If it is to stand before the world as the champion and guardian of the material welfare of a class it must abandon its traditional prestige as the unselfish exponent of professional standing and responsibility. If, on the contrary, it is to retain that prestige, it can only do so by the sacrifice of every selfish and material ambition, *as a society.*

Let us not be understood as denying the worth or usefulness of these new purposes now urged upon engineers. Let us admit that it is desirable that engineers shall organize for more effective participation in public affairs and for the advancement of the non-technical interests of the individual engineer. But there exists an organization created for exactly that purpose. It is already large and is still growing. To-day it is larger than the American Society of Civil Engineers or any other national Engineering Society. It represents engineers of every branch. Its energy and resources are to be devoted mainly, if not exclusively, to the very purposes now urged as so desirable. It is a going concern, and what is still more important, it will continue to go.

We can conceive of no proposition so unsound economically as that the American Society of Civil Engineers shall enter this new field of activity in competition with that organization, either alone or in federation with other societies. We can see not the slightest promise of success in duplicating, or attempting to duplicate, in the loosely co-ordinated fashion now proposed, with the divided and half-hearted interest that would surely prevail, and with the trifling resources now in sight, the work of a closely knit organization more than 13,000 strong, devoting its entire resources and energies to a single purpose.

To sum up, we believe that the creation and growth of the American Society of Civil Engineers has proved the need for its existence as a strictly technical and professional organization. It should not be forced, therefore, into new and untried fields of activity, the purposes of which are diametrically opposed to the purposes underlying its foundation and its life, and the work of which is already in other hands.

We believe that the only safe course open to the member who has at heart the future welfare and prosperity of the society, is to vote "No" to question 3 of the Questionnaire and we so urge.

The purpose of some of the other questions proposed in that document are not clear to us, but they are not so fundamental as those above considered, and therefore have not been discussed in this letter.

RALPH SMILLIE,
ORRIN L. BRODIE,
O. SINGSTAD,
MILTON H. FREEMAN,
JESSE B. SNOW,
JOHN A. O'CONNOR,
DWIGHT B. LA DU,
J. A. BENSEL,
S. WHINERY,
J. P. HOGAN,
J. J. YATES,
HOLTON D. ROBINSON,
H. R. WHEELER,
C. M. HOLLAND,
A. G. CHAPMAN,
J. S. SWINDELLS,
W. H. YATES,
W. T. CHEVALIER,
FRANCIS S. CROWELL,
M. E. FULLER,
C. R. HULSART,
PAUL G. BROWN,
ROYAL C. FINCK.

NEWS OF THE WEEK

New York, March 25, 1920

Threatened Water-Works Strike at Philadelphia Called Off

Water Bureau Ready for Emergency but International President Wired Local Union to Desist

After some months of agitation and a few days of keen anxiety and strenuous effort a threatened strike of Philadelphia water-works employees was called off a few hours after it was to have gone into effect on March 16. The Bureau of Water, of which Carleton E. Davis is chief, was ready for the emergency with loyal employees and outside help when the president of the international organization of the principal local union involved wired to the union to desist.

During the war the majority of employees of the Philadelphia Water Bureau were organized into unions affiliated with the American Federation of Labor. Various locals comprised unions of firemen, oilers and laborers; operating engineers; machinists; boilermakers, blacksmiths, patternmakers, bricklayers, etc. The first mentioned was the largest and has been most active through a paid representative, not an employee of the city.

From time to time various demands for increased wages have been presented to the City Council. These have not been met in full, but increases have been made ranging from slightly more than 50 per cent for the engineers up to 80 per cent for the laborers. In the preparation of the budget for 1920 the city authorities were confronted with certain definite demands, coupled with a threat of resignations to be submitted in a body on Jan. 2 if all demands were not met. An appeal to the common sense and sound judgment of the employees resulted in a postponement of the date set for the walkout with a view of taking up the matter with the incoming administration.

Shortly after the inauguration of J. Hampton Moore as mayor on Jan. 5, a committee of employees with their paid outside representative waited upon the mayor and presented their demands. Mr. Moore took the position that he had no objection to organization, but that he absolutely reserved to himself the right to deal with city employees first hand. Following this meeting there was a lull in agitation coincident with the absence in Washington at the railroad employees' conference of the paid representative of the union.

Upon the recent return of the latter to the city, agitation was renewed and

(*Continued on p. 646*)

American Railway Engineering Association Has Record-Breaking Annual Convention

Attendance and Volume of Work Handled Greater Than at Any Previous Meeting—New Bridge and Rail Specifications Adopted

Measured by attendance and volume of important committee work passed upon, the twenty-first annual convention of the American Railway Engineering Association, held at the Congress Hotel, Chicago, March 16-18, 1920, surpassed the record of any previous convention. Reports of twenty-two standing committees and two special committees were presented and the new specifications for iron and steel structures and for steel rail were adopted. The attendance exceeded by over 100 any other convention of the association, and on the last day was reported as 561.

President's Address

The meeting was opened March 16 by the president of the association, Earl Stimson, chief engineer maintenance, Baltimore & Ohio R.R. "The problems immediately ahead of us," said Mr. Stimson, "are those of maintenance, rather than those of construction." He said that the item of labor was greater than all other items of maintenance expense and that the engineer should seek to make the work attractive to the worker. More accurate cost accounting and unit measures of performance are needed on account of increased cost of both labor and materials in maintenance. The apparent shunning of railroad service by young engineers is a matter of concern and it should be the duty of members of the association to promote the possibilities of railroad engineering service and to help the younger men in every possible way toward their realization.

President Stimson also explained in detail the new relation of the American Railway Engineering Association to the American Railroad Association, and pointed out that fears of absorption by the body of executives were groundless. "At first it was proposed that the organization of this association be taken over by the American Railroad Association to become a part of its engineering section," said Mr. Stimson. "The propostion was voted down by this association by a large majority. The offer of this association to act as a division of the engineering section was finally accepted. The engineering section is presided over by a general committee of eleven members, six from the construction and maintenance division, three from the signal division, and two from the electrical division. This gives this association a majority of membership on the general committee. The president of this association is chairman of the general committee of the section and the secretary acts for both of

Prominent Hydraulic Engineer Enters Consulting Field

W. S. Lee, vice-president and chief engineer of the Southern Power Co. since its formation, will henceforth, in addition to those duties, engage in general consulting practice, chiefly along hydro-electric lines. He will maintain offices both in Charlotte, N. C., and in New York City. Mr. Lee has been responsible for the entire technical development of the organization with which his name is prominently identified, that development including the design and supervision of construction of no less than eight hydro-electric developments, with capacities ranging from 6,600 kw. to 70,000 kw. each, 2,050 miles of transmission line, and 200 substations. An idea of the service which this company renders can be gained from the fact that it supplies power to more than 200 cotton mills, 50 cities and towns, 150 miles of railway, nine street railway systems, a dozen cotton oil manufacturing plants, and the endless

WILLIAM STATES LEE

(*Continued on p. 646*)

these organizations." Now, the members of the A. R. E. A. committees act as members of like committees of the engineering section of the A. R. A. At the meeting of the American Railroad Association last November, the engineering section recommended approval of subjects adopted at the 1919 convention of the A. R. E. A., which were approved and now bear the endorsement of the A. R. A.

President Stimson reported a net gain in membership of 190 and a total membership of 1,639. The report of the secretary showed a present cash balance on hand of $43,774, with total annual receipts of $31,187, and disbursements of $24,702.

Bridge and Rail Specifications Adopted

After lengthy discussion, the convention adopted the new bridge specifications, with only minor changes, and the new specifications for steel rail as recommended by the committee without change. A report of the more important technical discussions of the convention appears on page 612. The convention adopted the report of the committee on track embodying new plans for frogs and switches. The committees on railway location and railway operation submitted reports including important studies of the probable effect of the new punitive overtime rates of pay for trainmen and enginemen. The report of the committee on yards and terminals, embodying important studies on unit operation of terminals, was adopted as a progress report. Specifications for truck-scales, as recommended by the committee on yards and terminals, were adopted. The convention accepted the second progress report of the special joint committee with the Am. Soc. C. E. on stresses in railroad track, with practically no discussion.

All specifications and plans, adopted by the convention, will be included in the new *Manual* to be issued during the year. While supplements to the *Manual* have been issued from time to time, a new volume has not appeared since 1915.

Following the presentation of the report of the special committee on standardization, a general sentiment was expressed for adopting more vigorous and postive methods to bring about a much wider use of the A. R. E. A. standards.

President Stimson presided as toastmaster at the annual dinner held on the evening of March 17 at the Congress Hotel. The Hon. and Rev. Henry J. Cody, member of the Legislature of Ontario, and former Minister of Education, spoke on "Education as a Factor in Reconstruction." Dr. Cody told of how the war had demonstrated the value of the trained man in industry and, now, in problems of reconstruction. Dr. Winthrop Ellesworth Stone, president, Purdue University, spoke on "The College and the Industries," emphasizing the need of closer contact of industry, including the railroads, with the universities in outlining programs of technical education. Dr. Stone called attention to the danger of the present tendency of engineering graduates to enter commercial fields rather than professional work, being attracted by prospects of so much greater compensation. University attendance, however, is increasing rapidly and a serious problem in providing for it has been created.

Election of Officers

New officers elected for the ensuing year are as follows: President, H. R. Safford, assistant to president, Chicago, Burlington & Quincy R.R.; vice-president, L. A. Downs, vice-president and general manager, Central of Georgia R.R.; treasurer, G. H. Bremner, district engineer, Bureau of Valuation, Interstate Commerce Commission, Chicago; and secretary, E. H. Fritch, Chicago. Three new directors were elected as follows: Edwin B. Katte, chief engineer of electric traction, New York Central R.R.; J. M. R. Fairbairn, chief engineer, Canadian Pacific Ry., and F. E. Turneaure, dean of the College of Engineering, University of Wisconsin.

The convention closed with the installation of new officers, and a brief address by Mr. Safford, in which he spoke of the new problems which lay before the association in subjects of economics and restoring morale in railroad service.

Belle Isle Bridge, Detroit, Can Now Go Ahead

Formal approval of the Belle Isle bridge, Detroit, Mich., without a draw span has been given by the War Department through Major General L. H. Beach, chief of engineers, U. S. Army. Due to opposition to a bridge without a draw a special act had to be passed by Congress. This bill was recently signed by the President. General plans were proposed in 1917 by a bridge commission headed by M. E. Cooley, so that working plans only remain to be completed. The detail work, which is being handled by Esselstyn, Murphy & Hanford, is estimated to require two months. After approval of the City Council separate bids will be asked on foundations and superstructure which are estimated to cost $3,000,000. Work is now under way on the subway approach to carry traffic under Jefferson Avenue at the north end of the bridge. The type of the bridge, cantilevers of concrete sprung from the piers with suspended links, was described in the *Engineering News-Record*, Aug. 2, 1917, p. 224

Asphalt Association Moves

Permanent headquarters for the Asphalt Association have been established in the new National Association Bldg., 25 W. 43rd St., New York City.

Road Construction Discussed in Various Aspects

Contradictory opinions as to the economy of building roads at no matter what cost were voiced at the regular bi-weekly meeting of the American Society of Civil Engineers, March 17. Out of the two-hour discussion participated in by half a dozen road engineers and others vitally connected with road construction work came the common admission that shortages in labor, materials and transportation would in the end automatically curtail the enormous 1920 program outlined.

Shirley Outlines Problem

H. G. Shirley, secretary of the Federal Highway Council, indicated what road engineers of the country were up against in providing improved roads for the 7,000,000 motor vehicles now licensed in the United States. He asserted that this year's program called for the construction of 5,000 mi. of hard surfacing and the needs of the present traffic call for a program at least four times as great and continuing for four years. Mr. Shirley stated that nothing should stand in the way of the prosecution of this year's program as he considered "we are just as able to build highways today as we ever were." However, in prosecuting this program he pointed out the dangers of building without a careful study of the subsoil, for, though considerable was known about the materials which constituted surfacing, "we know nothing of the subsoils," he added.

E. J. Mehren, editor of *Engineering News-Record*, took issue, on theory, with Mr. Shirley, asserting that in general new highways should not be built in which the carrying cost greatly exceeded the annual maintenance charges laid to the existing surface. Such procedure, Mr. Mehren asserted, was demanded of a public official in the efficient expenditure of the people's money. However, he was willing to admit that decrease in haulage charges due to road improvement might allow the expenditure of almost any figure upon road improvement. In general he stamped as economically unsound any plan that was liable at the present time to "bull" the material and labor markets.

Highways at $200,000 a Mile

Speaking on what extent money could be expended upon road improvement owing to decrease in haulage charges, G. H. Pride, of the Heavy Haulage Co., New York City, asserted that in the case where excessive commercial traffic passed over certain highways, an initial expenditure of $200,000 a mile was economic. Admitting the passage of 500 tons of freight over a certain highway in 24 hr., Mr. Pride asserted that the hard surfacing of such a highway would result in a daily saving of approximately $62. Multiplying this by 300 would save approximately $19,000 per mile per year, and in the life of ordinary hard

surfacing pavement would save approximately $200,000, justifying the excessive first cost. He also asserted that good roads meant the saving of at least $100 a year in gasoline, tires and oil to pleasure automobiles, and if there were 7,000,000 of these in the United States this meant an annual saving of $700,000,000, a great deal more than was even available this year in the United States for road construction.

Connecting Road Links Necessary

H. E. Hilts, principal assistant engineer, Pennsylvania State Highway Department, asserted that economic necessity demanded the construction of certain portions of highways at even most excessive prices. Where an unimproved portion was a connecting link in an all-the-year arterial highway, Mr. Hilts asserted that no financial appraisal of its usefulness could be set upon it.

As means of facilitating road construction work he recommended free use of daily and technical press, the clarification of specifications, the development of local material supplies, the selection of responsible contractors, the extensive use of industrial equipment, and the general co-operation of all parties to any road contract.

Motor Trucks and Railroads

R. S. Parsons, chief engineer, Erie R.R., pointed out several reasons in which the motor truck could be of inestimable value to the railroad in the movement of freight—in supplanting existing branch line railroads; in taking the place of branch lines that railroads would have to build to take care of a small amount of local freight; in taking care of short-haul freight in congested districts; in supplanting waterways in certain sections; in taking care of special problems of New York transportation. It was his assertion that a great opportunity was ahead of the motor truck in the elimination of the extra handling caused through trans-shipment by railroad, and in the development of truck terminals.

Mr. Parsons quoted some interesting figures to indicate why railroads could, with considerable profit, discontinue the handling of short-haul freight, asserting that less-than-carload freight could be shipped at $2 per ton less by motor truck from Jersey City to Paterson, N. J., the extra expense in railroad transportation coming from extra handling at termini, such fixed charges being the same for short or long hauls. He asserted that the railroads could be benefited by the general public ceasing to ship freight by railroad within a radius of 30 mi.

H. Eltinge Breed, a consulting highway engineer, New York City, made a plea for adequate maintenance grants, and W. G. Thompson, chief engineer, New Jersey State Highway Commission, gave an historical sketch of road building methods.

House Votes No Separate Construction Corps

Quartermaster General and Chief of Engineers Favor Construction by Corps of Engineers

Active work on the part of Representative Mondell, the majority leader in the House of Representatives, quite unexpectedly defeated, temporarily at least, the plan for a separate construction corps in the reorganized army. After the House in a committee of the whole had agreed by a seemingly safe majority to the Sanford amendment providing for a separate construction corps, as related in these columns last week, a separate vote on the amendment was demanded in the House proper, which resulted in the defeat of the proposal by a vote of 170 to 158. The reversing vote occurred too late for inclusion in the news of last week's issue. The vote in no way followed party lines, both parties being well represented on each side of the question. It is still possible that the Senate may insist upon a separate construction corps.

The general question involved in the handling of construction in the army was the subject of the following correspondence between Generals Beach and Rogers:

WAR DEPARTMENT,
OFFICE OF THE CHIEF OF ENGINEERS,
Wednesday, March 17, 1920.

Maj. Gen. HARRY L. ROGERS,
Quartermaster General,
Director of Purchase and Storage,
United States Army,
Washington, D. C.

MY DEAR GENERAL: 1. As you know, the Secretary of War has recently reiterated his previous recommendations that all construction work for the Army should be turned over to the Corps of Engineers in the reorganization bills now under consideration by Congress. Your views are requested for presentation to the military committees of the Senate and House upon this matter.

2. It is regarded as advisable to have this work of construction and the major maintenance work invloving important alterations of structures placed under the Corps of Engineers, in order to prevent overlapping and duplication of construction activities in peace and war, and to furnish this most valuable means of training for our Engineer officers in peace for their construction duties in war. It is believed that this work should be turned over to the Corps of Engineers and the operation of utilities left with the various services principally concerned therein; for instance, the utilities within the arsenals by commanding officers thereof, those within the posts, such as bakeries, fire protection, laundries, and so on, by the Post Quartermaster, as was done previous to the war.

3. I am firmly convinced that the consolidation of the various activities of Transportation, Motor Transport, Finance, and operation of utilities at posts under the Quartermaster will be far more advantageous and economical than the present multiplicity of agencies with their unnecessary overhead and expense.

Yours, respectfully,
LANSING H. BEACH,
Major General, Chief of Engineers.

MARCH 17, 1920.

Maj. Gen. LANSING H. BEACH,
Chief of Engineers, United States Army,
Washington, D. C.

MY DEAR GENERAL: I am pleased to acknowledge receipt of your letter of the 17th instant, in which you voice the opinion that the consolidation of the various activities of transportation, motor transport, finance, and the operation of utilities at

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Machinery for Settling Labor Disputes

The President's Industrial Conference, generally known as the Second Industrial Conference, made its report March 20. In general it follows the lines of the preliminary statement sent out for discussion in December. It provides permanent machinery for settling industrial disputes. One of the interesting suggestions of the report is that, since many engineers go into executive positions, engineering schools should provide courses in which the "pyschological and industrial background for human relations" will be developed. It will be remembered that Herbert Hoover is vice-chairman of the conference.

The report states that the conference first agreed that as industrial problems vary not only with each industry but in each establishment, the strategic place to begin battle with misunderstanding was within the industrial plant itself. If the joint organization of management and employees in the plant or industry failed to reach a collective agreement, the conference proposed a system of settlement under governmental encouragement.

This system of settlement consists of a plan, nation-wide in scope, with a national industrial board, provided for by Congress, which shall have headquarters in Washington and be composed of nine members appointed by the President and confirmed by the Senate, and also local regional conferences and boards of inquiry.

The parties to the dispute may voluntarily submit their differences to a board known as the regional adjustment conference, composed of four representatives selected by the parties and four others in their industry chosen by them. The board would be presided over by a trained Government official, who would act as conciliator. If unanimous agreement were reached it would result in a collective bargain, having the same effect as if reached by joint organization in the shop.

If the regional conference failed to agree the matter would go to the National Industrial Board unless the parties preferred the decision of an umpire selected by them.

Voluntary submission of a dispute to the regional adjustment conference would carry an agreement by both parties that there should be no interference with production pending the process of adjustment.

If the parties, or either of them, refused to submit the dispute to adjustment, a regional board of inquiry would be formed by the regional chairman, of two employers and two employees from the industry and not parties to the dispute.

This board of inquiry would have the right to subpoena witnesses and records, and must publish its findings as a guide to public opinion. The weight of public opinion as guided by these findings, it is believed, would bring about justice in the last analysis.

Either side to a controversy would be permitted to submit its contentions to a regional adjustment conference of this kind if so desired.

The National Industrial Board at Washington would have general oversight of the plan.

War Department Asks Bids on Light-Weight Rails

Through the director of sales the Corps of Engineers is offering for sale by informal bids a quantity of special-size rail and track materials, stored at different parts of the country, bids for which will be received until 4:30 o'clock on the afternoon of March 29, 1920, by the Chief of Engineers, Room 2706, Munitions Building, Washington, D. C.

Included in the materials offered are: 1,333 gross tons of 67.53-lb. Russian rail in standard lengths, stored at Norfolk, Va., and Kearney, N. J.; 1,091 gross tons of 35-lb. A. S. C. E. rail in 15-foot lengths, undrilled, located at Norfolk, Va., Kearny, N. J., Port Newark, N. J., and Philadelphia; 1,101 gross tons of 30-lb., A. S. C. E. rail in 26-foot lengths, drilled, located at Kearney, N. J.; 2,946 gross tons of 25-lb. A. S. C. E. rail in 8, 10 and 12-ft. lengths, undrilled, located at Norfolk, Va., Kearney, N. J.; Port Newark, N. J., New Cumberland, Pa., and Philadelphia. Bolts, connections and track material are also offered.

Lee Enters Consulting Field

(*Continued from p. 643.*)

variety of factories in the industrial territory which has been built up since the introduction of hydro-electric power in North and in South Carolina.

While Mr. Lee's designated function was the technical development, he has been an important factor in the molding of the broad policies which have resulted in developing the Southern Power Co. from a small beginning, the nucleus of which was the 6,600-hp. plant of the Catawba Power Co. to the present gigantic system.

Mr. Lee was born at Lancaster, S. C., and took up his engineering work at The Citadel Military College of South Carolina. Immediately upon graduation, in 1894, he began work with the Pickens Railway Co. His entrance into hydraulic work was with the Anderson Water, Light & Power Co., for which, as resident engineer, he had charge of the construction of a hydro-electric plant at Portman Shoals on the Seneca River. He here installed the first 11,000-volt generator in service in America. Subsequently he was engaged upon the construction of coast defenses for the United States Government at Charleston Harbor, and then returned to hydraulic work, as resident engineer for the Columbus Power Co., Columbus, Ga., his initial employment being on the reconstruction of a dam on the Chattahoochee River. This stream had an ill reputation. Its floods rose quickly and often exceeded fifty times the normal flow. Soon after the completion of the original dam it was damaged by flood, and it was Mr. Lee's first work to repair the damage. The structure was modified in design and raised in height, and on being completed in 1902 was the first large dam built in the South.

As a result of his successful work on this structure, the Catawba Power Co., then struggling under conditions similar to those encountered by Mr. Lee on the Chattahoochee, prevailed upon him to become their chief engineer. Owing to the persistent floods, three contractors had failed to effect the construction of the company's dam and plant at India Hook Shoals, near Rock Hill, S. C. Mr. Lee went in and brought them to completion in 1904, together with transmission lines to Rock Hill and Charlotte. This company formed the nucleus of the Southern Power Co. Purchases were soon made of water-power rights on the Catawba and Broad Rivers and the larger organization effected in 1905, with Mr. Lee as vice-president and chief engineer.

Previous to the formation of the Southern Power Co., hydro-electric development in the South had been local in scope having for its object the supply of power to a few cotton mills in the immediate neighborhood of the power plant or at a comparatively short distance therefrom. The plans of the Southern, however, were laid on a broad scale and the vision of the promoter, J. B. Duke, ably seconded by Mr. Lee and other associates, has been more than realized.

In connection with his hydro-electric work, Mr. Lee has made a very thorough study of the distribution of rainfall over the Piedmont district. Often there were great disparities in the flow of streams not far apart so that while one power company would have a surplus of power, another would be short of its requirements. To relieve the situation Mr. Lee evolved the plan of tying up the various plants on the same stream, then those on different streams, and finally connecting all the plants in the same general region. A connection on the east with the Carolina Light & Power Co., between Durham and Raleigh, N. C., and with the Georgia Railway & Power Co. on the south, at Tallulah Falls, Ga., made it possible to have rains in one part of the country contribute to those sections where there was a dearth of flow. To enumerate all of his achievements in hydro-electric practice is out of the question in a brief article, but the summary given above of the extent of the system which has been developed under his technical guidance is sufficient to indicate that a tremendous amount of technical development work of a high order was necessary.

Mr. Lee is a member of the principal engineering societies of electrical, mechanical, and civil engineers, and also of the Canadian Society of Civil Engineers.

Two License Bills in New York State Legislature

Licensing bills were introduced in the state legislature of New York on March 17 by a committee of the American Association of Engineers and by Albany engineers. The former is understood to be similar to a bill that was before the legislature in 1913. It is expected that the two bills will be consolidated while under consideration by the legislative committees.

Urban Transport Study

A resolution has been introduced in the Massachusetts Legislative Assembly authorizing the Department of Public Utilities to direct an immediate investigation of the comparative safety and cost of service of transportation over highways and street railways. A report is called for which will present briefly comparative figures on the operation of rail and non-rail, common passenger carriers utilized in London, Paris and Berlin during 1913.

Chicago Building-Height Limit Raised Sixty Feet

The Chicago City Council voted, March 18, to remove the limit of building-height, which had been held at 200 ft. for the past six years, and establish a new limit of 260 ft. Many very large projects which have been held in abeyance for some time on account of the former low limit are expected to begin building soon.

Threatened Water-Works Strike

(*Continued from p. 643*)

at a meeting under his control on Sunday, March 14, it was voted that the entire body of employees affiliated with the union would walk out on Tuesday, March 16, at 7 a.m. Notice to this effect was received by the Bureau officials on Monday the fifteenth.

Notice was at once given to all employees that those who left the service under such conditions would not be reemployed. Loyal employees were already known and a skeleton organization was ready to operate the pumping stations in case of emergency. Outside help was drawn upon and everything was in readiness for a show-down Tuesday morning, March 16. On the preceding evening a telegram was received from the international president of the Brotherhood of Firemen, Oilers and Laborers calling off the strike. It is understood that this president has subsequently been in Philadelphia, has discharged the paid representative of the union and has taken the sound position that the American Federation of Labor will in no way countenance any movement which will interfere with an essential municipal activity.

It is reported on good authority that the majority of Water Bureau employees are many months in arrears in their dues to the union and it is alleged that the union is substantially dead in so far as the Bureau of Water is concerned.

Los Angeles Aqueduct Power Plant Nearing Completion

San Francisquito power house number two on the Los Angeles aqueduct is well along toward completion and is expected to be ready for service by June 1. Work on the power house proper and on the two penstock lines is in progress and part of the water wheel equipment, which is being supplied by the Wellman-Seaver-Morgan Co., is now on the way west. This plant, which will utilize the drop next below plant number one, will have at the outset two 17,500 kva. units driven by reaction turbines under a 530-ft. head. Only one mile of transmission line is required to tie it in with the 110,000-volt line now delivering power to Los Angeles from plant one.

Separate Construction Corps

(Continued from p. 645)

posts, under the Quartermaster Corps, will be far more advantageous and economical to the Government than would be the separation of these activities, with the consequent unnecessary overhead expense.

I have carefully considered the suggestion contained in the second paragraph of your letter, and in view of the recent recommendation of the Secretary of War, I am of the opinion that the interests of the service will be as well served if all original and new projects of construction work formerly carried on by the Quartermaster Corps and lately by the construction division were turned over to the Engineer Corps. This would leave with the Quartermaster Corps the handling of all utilities and maintenance at Army posts, and depots and other activities of the Quartermaster Corps.

For the sake of economy and the utilization of supplies and personnel already available in the Quartermaster Corps at Army posts, depots, and other activities of the Quartermaster Corps, it is deemed essential that maintenance and repairs and utilities at such places should be, as heretofore, included in the duties of the Quartermaster Corps.

The necessity for the operation of utilities being left with the bureau or service responsible for the activity is beyond argument. The functions which have been recently ascribed to utilities officers of the construction division are absolutely essential at both arsenals of the Ordnance Department and depots of the Quartermaster Corps, as part of the responsibility of the commanding officers thereof in the economical and efficient management of their plants.

Yours, respectfully,
H. L. ROGERS,
Quartermaster General, United States Army.

Representative Reavis Speaks for Separate Construction Corps

In advocating a separate War Department Construction Division on the floor of the House recently Representative Reavis of Nebraska admitted that creation of such an organization might serve as an opening wedge for his Public Works Department bill, which, if passed, he said, would save the Government more money than could anything else he knew of.

"The bill I have introduced, and on which I hope the House will give me an opportunity to speak before long," said Mr. Reavis, "will take the same Construction Corps by detail out to the several States to assist in building those roads that are being constructed with Federal aid, and we will make these officers serviceable, not only in peace time, but, by so doing, will equip them for service in time of war."

Bill Regulates Motor Truck Sizes and Loading

A bill designed to limit the size of motor trucks and the weight of their loads, and introduced by Senator M. Y. Ferris, Republican, has passed the New York State Senate. The bill limits trucks to 8 ft. in width and 12½ ft. in height, and 25,000 lb. for weight of truck and load.

Robinson and W.-C.-K. Firms Merged

By vote of the stockholders, announced last week, the firm of Westinghouse, Church, Kerr, Inc., engineers and constructors, has been merged with that of Dwight P. Robinson & Co., Inc., construction engineers, under the name of the latter organization.

Propose Ohio River Bridge at Louisville

Discussion of the project of a highway bridge across the Ohio at Louisville is reported. The idea is credited to Mayor Smith of Louisville; officials of New Albany and Jeffersonville, across from Louisville, have expressed themselves in its favor.

C. P. R. Orders $15,000,000 Equipment

The Canadian Pacific Railway has placed equipment orders totaling $15,000,000. They include 2,500 sixty-ton box cars, 500 refrigerator cars, 500 automobile cars, 67 ore cars, 12 dining cars, 53 sleepers, 13 compartment cars, and 24 baggage cars.

Virginia Passes Engineers Certification Bill

Examination and certification of professional engineers, architects and land surveyors is provided for in a bill recently passed by the State Legislature of Virginia. While the bill in its present form is considerably different from the one originally introduced it is considered a step in the right direction. As drawn it is optional whether an engineer, architect or land surveyor secures such a certificate, but he must do so "to be known as a certified professional engineer, certified architect or as a certified land surveyor."

Salient points in the law are as follows: The Governor appoints the board which is made up of three of each kind, a majority of whom pass on their specialty as in the Engineering Council bill. Board members receive $10 per day for the time spent. Examinations cost $20. Surplus money over $500 annually goes into the library fund of the State. Engineers and architects having previously practiced for six years and land surveyors for two years are to be granted a certificate without examination upon payment of a $5 fee. Prerequisites of candidates for examination are citizenship or intention, age 21 years, good character, four years' practical experience (two years if surveying), or graduation from a recognized college. As in the Engineering Council bill engineers may practice architecture and architects engineering. The bill is operative within six months and the penalty for assuming the titles without certification is deemed a misdemeanor punishable by a fine of not to exceed $100. Revocation follows proof of fraud or deceit in professional practice, conviction of felony, gross incompetency or recklessness in the planning or construction of work, habitual drunkenness or addiction to morphine, opium or cocaine. Reciprocity with other states is provided for.

ENGINEERING SOCIETIES

Calendar

Annual Meetings

NATIONAL FIRE PROTECTION ASSOCIATION, 87 Milk St., Boston; May 4-6; Chicago.

AMERICAN ASSOCIATION OF ENGINEERS; 63 E. Adams St., Chicago; May 10, 11, St. Louis, Mo.

AMERICAN WATER WORKS ASSOCIATION, New York City; Montreal, June 21-26.

AMERICAN SOCIETY FOR TESTING MATERIALS, Philadelphia; Asbury Park, N. J., June 22-25.

AMERICAN PUBLIC HEALTH ASSOCIATION, Boston; San Francisco, Aug. 30-Sept. 3.

The Seattle Association of Members, Am. Soc. C. E., held its regular monthly meeting March 2. Extracts from correspondence concerning the annual meeting of the society in New York, and particularly on the report of the Development Committee, were read. It was agreed that the president should prepare and send a circular to all members of the Seattle association urging them to vote on the questionnaire, and at as early a date as possible. President John L. Hall was re-elected, and T. E. Phipps elected, representatives to the Joint Council of the Associated Engineering Societies. The association went on record as advocating that the new mayor of Seattle appoint an engineer to fill any vacancy occurring on the Board of Public Works, and the president was authorized to appoint a committee to present the views of the association to the mayor regarding such appointive offices.

The Technical Club of Dallas (Tex.), the membership of which includes engineers of all branches, has endorsed the Jones-Reavis bill, now pending in Congress, and has made an assessment of one dollar on each of its 107 members as a contribution to the fund maintained by the National Public Works Department Association to promote the interests of the bill.

The Mohawk Valley Engineers' Club (New York State), at its meeting held at Utica, N. Y., March 18, was addressed by Edwin S. Carman, president, Cleveland Engineering Society, who gave a review of the industrial situation in the United States and Europe. Prof. W. H. Kenerson, Brown University, Providence, R. I., also spoke on the world industrial situation, and C. A. Booth, Buffalo Engineering Society, delivered a few remarks on local sections.

PERSONAL NOTES

ARTHUR E. MORGAN, chief engineer of the Miami Conservancy District, is the author of an article on "New Light on Lincoln's Boyhood," which appeared in the *Atlantic Monthly* for February. Mr. Morgan picked up the information from relatives of Lincoln whom he found in a very remote section of Arkansas.

F. T. CROWE has resigned his position as Project Manager of the Flathead irrigation project effective as of March 1, 1920. He will be associated with Rich & Markhus, contractors of Prosser, Wash. Mr. Crowe entered the reclamation service in 1904 and was connected with the Yellowstone & Minidoka projects and with the construction of the Jackson Lake dam in Wyoming and the Arrowrock dam in Idaho.

COLONEL GEORGE A. JOHNSON of the Construction Division of the Army has resigned his commission to assume his duties as the directing head of the engineering firm, Johnson & Benham, whose formation was announced in these columns some time ago. Hitherto, Major Webster L. Benham has been directing the affairs of the firm which has offices in New York City and in Kansas City, Mo. The specialty of the organization whose general direction Colonel Johnson will assume is the design, construction supervision and management of water supply and sewerage plants and other public utilities.

MAX L. CUNNINGHAM, formerly of the Oklahoma Highway Department, whose resignation became effective recently, has become vice-president and chief engineer, Municipal Excavator Co., Oklahoma City, Okla.

ANDREW H. HARKNESS, formerly with Harkness & Oxley, Thos. R. Loudon and C. S. L. Hertzberg, formerly with James Loudon & Hertzberg, Ltd., have opened offices in the Confederation Life Bldg., Toronto, and will practice as consulting engineers and architects under the firm name of Harkness, Loudon & Hertzberg.

A. MCDOWELL, consulting engineer, Owen Sound, Ont., has been appointed engineer of Grey County.

E. M. BOURKE has been appointed city engineer of North Bay, Ont.

JOHN H. WILSON, city engineer of Honolulu, T. H., has been appointed mayor of that city, succeeding the late Joseph J. Fern. Fred Ohrt will take Mr. Wilson's position as city engineer. Mr. Wilson was born in Honolulu in 1871. He studied engineering at Leland Stanford University and returned to Honolulu in 1896; since then he has been constantly engaged on municipal and county improvement work, particularly the construction of the Pali road and more recently the round-the-island thoroughfare known as the Kamehameha highway.

C. P. PRANN, formerly assistant city engineer, New Haven, Conn., has been appointed city engineer, Meriden, Conn.

CAPTAIN BILLINGS WILSON, Corps of Engineers, U. S. Army, has resigned from the service, effective April 1, to take a position with Francis Lee Stuart, consulting engineer, New York City.

ERNEST DRINKWATER, for the past eight years prominently identified with contracting work and municipal improvement at St. Lambert, P. Q., has been appointed city engineer.

C. F. LEWIS has resigned his position with the U. S. Bureau of Public Roads to open offices in Greensboro, N. C., under the firm name of Spoon & Lewis, consulting engineers. The firm will render general consulting service, giving particular attention to highway and municipal work.

MAJOR ROBERT C. WHEELER, chief of water supply section, Construction Division, U. S. Army, recently discharged, and at the time of leaving associated with Captain Harry Barker, New York City, in the general practice of engineering, sailed March 16 for Athens, Greece, with a party of engineers organized by Ford, Bacon & Davis to prepare plans and estimates for the water supply and sewerage of Athens. Mayor Wheeler will be in charge of the work on water distribution, sewage collection in that city and methods of sewage disposal. The work will require about six months and on its completion he will return to New York and resume active participation in the work of his firm.

M. E. CROUCH, Sudbury, Ont., has been appointed town engineer, Paris, Ont.

C. W. TARR, vice-president and general manager, Morris Knowles, Ltd., Windsor, Ont., Canadian branch of Morris Knowles, Inc., Pittsburgh, has resigned to become resident engineer for the same firm on the construction of a water filtration plant at Elyria, Ohio.

JOHN HANSON, assistant state engineer, North Dakota Highway Commission, has resigned to engage in private engineering practice. It is reported that he will be affiliated with a Hebron concern. Thomas Lough, of the commission, has been selected to fill Mr. Hanson's place.

LIEUTENANT JOSEPH A. MURRAY, JR., recently assistant engineer in charge of sewage disposal, has been appointed principal assistant engineer, bureau of engineering, Albany, N. Y.

H. F. FERGUSON, assistant to Paul Hansen, chief, division of sanitation, Illinois Department of Public Health, who recently resigned to join the firm of Pearse, Greeley & Hansen, will become acting chief engineer of the division pending a permanent appointment. M. C. Sjoblom, assistant to Captain Hansen, will become principal assistant engineer.

H. E. BARLOW, assistant engineer, Chicago, St. Paul, Minneapolis & Omaha Ry., since 1902, has been appointed chief engineer, with office at St. Paul, Minn. He succeeds H. Rettinghouse, who has retired, to enter other business.

H. P. PADLEY, principal assistant engineer, Chicago, St. Paul, Minneapolis & Omaha Ry., has been appointed assistant chief engineer.

LEROY KISSAM, recently engineering draftsman, plant department, Bayles Shipyard, Inc., Port Jefferson, N. Y., has entered the design division, engineering department, E. I. Du Pont de Nemours Co., Wilmington, Del.

RUDOLPH P. MILLER, New York, has been nominated for chairman, executive committee, National Fire Protection Association. The nomination will be voted upon at the annual meeting of the association to be held May 4-6, in Chicago.

R. C. HAMM has been appointed engineer of Ford County, Kan., with headquarters in Dodge City. He succeeds T. J. Shall.

L. B. CARUTHERS, JR., has resigned from the engineering department, American Rio Grande Land & Irrigation Co. of Mercedes, Tex., to become associated with W. W. Vann and Charles McKercher under the firm name of Vann, Caruthers & McKercher, civil engineers. The firm will have its headquarters in Mercedes, and will give special attention to the design and construction of irrigation systems and reinforced concrete structures throughout the Lower Rio Grande Valley.

SIR ADAM BECK, chairman, Ontario Hydro-Electric Power Commission, who has been absent for several months in England, has returned to Canada and resumed his duties.

C. I. BURGRAFF has resigned from the Illinois State Highway Department to accept a position as bridge engineer with the Morgan Engineering Co., Memphis.

J. O. BUTTERFIELD has entered the employ of the Morgan Engineering Co., Memphis. He will be stationed near Greenville, Miss., on the construction of a drainage pumping plant. Mr. Butterfield was formerly with Central Romana, La Romana, Dominican Republic.